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ABSTRACT

Il presente elaborato vuole determinare l'importanza e la centralità delle misure di contrasto delle città in risposta ai cambiamenti climatici nel tentativo di sviluppare l'ormai fondamentale denominazione di città resilienti, sottolineando gli effetti e le ripercussioni che il surriscaldamento globale ha ed esercita nelle aree urbane e sui loro abitanti. Di fatto, lo scopo principale è quello di dimostrare la crescente centralità delle aree urbane nelle politiche di contrasto degli effetti del cambiamento climatico, con l'idea che queste insieme alla varietà di attori che le caratterizzano – cittadini, imprese, autorità locali, organizzazioni no profit – possano rappresentare una soluzione vincente per tutelare e salvare il pianeta.

L'analisi proposta inizia considerando l'evoluzione degli studi sulle cause e sulle conseguenze del cambiamento climatico a partire dagli anni Settanta del secolo scorso, quando la relazione tra l'aumento delle temperature e le attività antropiche iniziava ad essere evidente, e il processo di urbanizzazione si faceva sempre più intenso. Successivamente, tra gli anni Ottanta e Novanta, iniziava anche a definirsi il regime climatico emanato dall' Organizzazione delle Nazioni Unite sulle orme dei lavori emersi nel corso del secolo, a partire da *Primavera silenziosa* di Rachel Carson al *Rapporto sui limiti dello sviluppo* redatto dal Club di Roma su commissione dell'Istituto di Tecnologia del Massachusetts (MIT), considerati pietre miliari alla base degli studi ambientali sui mutamenti climatici. Nel 1972, a seguito del lavoro *Only One Earth* di René Dubois e Barbara Ward, si delinea la Conferenza di Stoccolma, in cui viene evidenziato l'impatto delle attività umane sull'ecosistema. Come conseguenza di Stoccolma 1972, nel 1992 la Conferenza delle Nazioni Unite sull'ambiente e lo sviluppo che si tiene a Rio de Janeiro si concretizza nella Convenzione Quadro delle Nazioni Unite sui cambiamenti climatici (UNFCCC). A seguito del Summit della Terra, si avverte la necessità di delineare uno nuovo strumento normativo che comprendesse ciò che era delineato nell'UNFCCC. A tal fine, durante la terza Conferenza delle Parti (COP) del 1997, nasce il Protocollo di Kyoto con l'obiettivo di ridurre, tra il 2008 ed il 2012, le emissioni di gas serra del 5 percento rispetto ai precedenti livelli del 1990. Il protocollo di Kyoto si basa sul principio delle "responsabilità comuni ma differenziate" distinguendo i paesi non-industrializzati da quelli industrializzati, i quali, elencati nell'Allegato B, devono seguire degli obiettivi vincolanti per la riduzione delle emissioni di CO_2. Successore del Protocollo di Kyoto, l'Accordo di Parigi rappresenta il risultato finale della COP21 tenutasi a Parigi nel Dicembre del 2015. Vincolante per i sottoscrittori, esso si pone quali obiettivi il contenimento dell'aumento della temperatura media globale al di sotto dei 2 ºC rispetto ai livelli preindustriali e la limitazione dell'aumento della

temperatura a 1,5 ºC al di sopra dei livelli preindustriali, missioni da realizzarsi attraverso l'utilizzo dello strumento dei contributi determinati a livello nazionale (NDC), che inducono gli stati membri a comunicare – ogni 5 anni - gli sforzi e le misure adottate nel tentativo di realizzare gli obiettivi dell'Accordo stesso.

Tracciando le tappe fondamentali del regime climatico delle Nazioni Unite (ONU), si vuole fare luce su quanto le conseguenze dei cambiamenti climatici si siano aggravate nel corso degli ultimi decenni, rappresentando un moltiplicatore di stress soprattutto per i paesi in via di sviluppo e unendosi a situazioni di forte instabilità, tra cui conflitti regionali, flussi migratori internazionali, e povertà, mostrando come gli accordi multilaterali in materia ambientale degli ultimi decenni rappresentino una presa di coscienza da parte della comunità internazionale. Successivamente, l'elaborato analizza come gli effetti del surriscaldamento globale colpiscano duramente le aree urbane, evidenziando quanto lo stile di vita di molte città sia oggigiorno insostenibile e sbilanciato, richiedendo un intervento immediato. Infatti, le città rappresentano il target principale degli impatti dei cambiamenti climatici, esposte ad alluvioni, frane, temperature estreme, ondate di calore, innalzamento del livello del mare, intense precipitazioni, cicloni tropicali e siccità. Basti pensare al Sud-est Asiatico, le cui aree urbane sono situate prevalentemente al di sotto del livello del mare e sul delta dei principali corsi fluviali, rendendole altamente esposte all'innalzamento del livello dei mari, alluvioni, mareggiate, ed erosione costale. Si prevede che città come Bangkok, Jakarta e Ho Chi Minh a causa dei rapidi cambiamenti climatici siano destinate ad affondare, una tendenza che purtroppo è già evidente. Al tempo stesso, le città rappresentano tra le prime generatrici di emissioni di gas serra, consumando circa il 70 percento dell'energia globale e contribuendo in maniera invasiva al surriscaldamento globale – e agli impatti che ne derivano. Il sistema di trasporti, l'energia generata da edifici pubblici ed abitazioni private, le attività industriali nelle aree urbane e periurbane, la crescente produzioni di rifiuti sono solo alcuni dei fattori che contribuiscono all'emissione di gas a effetto serra. Pertanto, diventa imperativo creare degli ambienti resilienti, adattandosi alla nuova realtà di un clima in continuo mutamento.

A tal proposito, il concetto di resilienza in termini ecologici viene delineato per la prima volta dallo studioso canadese Crawford S. Holling, che nel suo lavoro *Resilience and Stability of Ecological Systems* (1973), la definisce come ciò che permette ad un sistema socio-ecologico di assorbire cambiamenti e continuare a mantenere le sue principali funzioni e relazioni. Al concetto di resilienza viene contrapposto quello di vulnerabilità, necessario per comprendere il grado di esposizione ad un rischio ambientale a cui una determinata area è sottoposta. Pertanto, risulta fondamentale prevedere e misurare il grado di esposizione al rischio di un centro urbano

e le relative infrastrutture, attraverso sistemi di valutazione e analisi della vulnerabilità. Un esempio in tale contesto è stato svolto dall'UN-Habitat (Programma delle Nazioni Unite per gli insediamenti umani) nella città di Pakse nel Laos, situata lungo il Fiume Mekong, in cui viene accuratamente valutata l'esposizione al rischio della città considerando i principali fattori geografici e sociali, essendo la città caratterizzata da abitazioni instabili e un'economia precaria. Nonostante l'area sia frequentemente colpita da calamità naturali – repentini cambi stagionali, alluvioni e forti precipitazioni – i cittadini di Pakse hanno trovato il modo di adattarsi, seppur in maniera temporanea e precaria, a questa condizione di instabilità ambientale. A tal proposito, questa tesi ha esaminato diversi casi di città resilienti, tra i più noti quello della città di Curitiba in Brasile, considerata un esponente di rilievo per la sua praticità e tempestività nel trasformarsi in un centro verde e resiliente agli impatti dei cambiamenti climatici, sviluppando un efficiente sistema di trasporto urbano e un'ampia rete di parchi e zone ricreative.

In questo contesto, non si può non sottolineare l'importanza e la necessità di un sistema di governance inclusivo e sostenibile, dove un ruolo di rilievo è ricoperto dalla collaborazione tra organizzazioni non-governative, il ruolo della *civil community,* attori statali, imprese, organizzazioni regionali. A tal proposito sono di rilievo le riflessioni del teorico Oran Young, che sottolinea l'importanza di possedere degli strumenti adeguati, delle risorsi e dei regimi di governance ambientali che possano sostenerci in un'era e per un futuro a caratteri sempre più antropocentrici. Al tempo stesso, la studiosa Harriet Bulkeley ci offre un'interessante prospettiva secondo cui una comprensione della governance ambientale urbana è possibile attraverso una serie di pratiche che possano permettere, attraverso le note misure di adattamento e mitigazione, di affrontare al meglio la crisi ambientale.

In tale contesto, il lavoro di organizzazioni regionali ed internazionali è di spicco, tra queste il Programma delle Nazioni Unite per gli insediamenti umani (UN-Habitat) e il Programma delle Nazioni Unite per l'ambiente (UNEP), la *Local Agenda 21,* la *New Urban Agenda* e l'Agenda 2030 per lo Sviluppo Sostenibile dell'ONU in cui sono definiti 17 Obiettivi di Sviluppo Sostenibile con lo scopo di favorire al meglio uno sviluppo e una transizione climatica sostenibile, in cui l'Obiettivo 11 si propone di "rendere le città e gli insediamenti umani inclusivi, sicuri, duraturi e sostenibili." Al di fuori del contesto delle Nazioni Unite sono molteplici i network internazionali e regionali di città resilienti. C40 Cities raggruppa i sindaci delle maggiori città globali, in prima linea nella lotta al cambiamento climatico. Di pari importanza sono l'Unione delle città e dei governi locali (UCLG), il *Global Covenant of Mayors for Climate & Energy,* il *Local Governments for Sustainability* (ICLEI), la *Carbon Neutral Cities Alliance* (CNCA), e il *Resilient Cities Network*, i cui membri comprendono

quelle del *100 Resilient cities*, la rete di città resilienti lanciata nel 2013 dalla Fondazione Rockefeller. La *Race to Zero* e la *Race to Resilience* sono nate nell'ambito della ventiseiesima Conferenza delle Parti tenutasi a Glasgow durante le prime settimane del novembre scorso, il più grande e atteso evento internazionale in tema di cambiamenti ambientali. L'importanza della creazione di network internazionali e regionali permette alle città di avere un confronto diretto su una molteplicità di aspetti, permettendo loro di migliorare laddove è necessario, e supportare pratiche resilienti di adattamento al cambiamento climatico.

L'adattamento climatico è un concetto relativamente recente, che ha ricevuto maggiore importanza solamente a partire dal Protocollo di Kyoto – delineato nell'Articolo 10 – il quale è stato poi riconfermato nell'Articolo 7 dell'Accordo di Parigi, dove si sottolinea l'obiettivo di perseguire misure di adattamento e supportare i paesi in via di sviluppo nell'incrementare la capacità di adattamento. A livello internazionale, i Programmi Nazionali di Adattamento (NAPA) sotto proposti dell'UNFCCC, intrapresi dai paesi in via di sviluppo, le cui città sono ben più esposte a rischi ambientali. Inoltre, nello scenario internazionale, si stanno affermando sempre di più le cosiddette *nature-based solutions* (NbS), in cui si cerca di sviluppare misure di adattamento che utilizzino elementi naturali o che siano improntanti al ripristino di ecosistemi naturali che possano funzionare da barriere contro gli impatti climatici – ad esempio, le foreste di mangrovie e le barriere coralline. Le azioni basate sulla natura sono ampiamente utilizzate nei centri urbani attraverso la creazione e l'espansione di aree verdi, l'inserimento di piante, arbusti e vegetazione varia sulle facciate degli edifici, l'integrazione di veri e propri giardini, orti e alberi in cima agli edifici al fine di mitigare gli effetti più invasivi dei cambiamenti climatici, specialmente in casi di forte ondate di calore (che creano l'effetto di isola di calore urbana) e intense precipitazioni. Emblematico in questo senso, è il Bosco Verticale dell'architetto Stefano Boeri nel centro della Città di Milano. Per concludere il concetto generale di resilienza e adattamento, è opportuno sottolineare la differenza – non sempre evidente – tra queste due nozioni. Se da un lato il concetto di resilienza s'identifica come l'abilità di un sistema di far fronte ad un determinato shock e ritornare al suo stato di equilibrio, quello di adattamento si basa sul processo di adeguamento di un sistema o una comunità in risposta ad un determinato stress – in questo caso, dei cambiamenti ambientali. Risulta perciò automatico pensare che l'adattamento ai cambiamenti climatici rappresenta una caratteristica essenziale della resilienza, permettendo alle comunità e ai centri urbani di far fronte agli impatti ambientali, superandoli ed imparando a convivere con essi, rendendo di conseguenza le città centri resilienti.

Successivamente a livello europeo, i principali strumenti giuridici in materia ambientale emanati nel contesto dell'Unione Europea sono rappresentati dal Green Deal Europeo, la Normativa europea sul clima (*European Climate Law*) con l'obiettivo di rendere l'Europea il primo continente a emissioni zero. Alla base della presente normativa, il *Climate Target Plan* propone una riduzione delle emissioni del 55 percento entro il 2030 rispetto ai livelli del 1990. Di rilievo, è la Strategia dell'Unione Europea di adattamento ai cambiamenti climatici del 2013, con l'obiettivo generale di promuovere e sostenere le iniziative di adattamento degli Stati membri, adottare misure di contrasto ai cambiamenti climatici a livello UE, stimolare un processo decisionale basato su dati e conoscenze scientifici. Addentrandoci verso il livello urbano europeo, è importante menzionare il Comitato Europeo delle Regioni e il Consiglio dei Comuni e delle Regioni d'Europa. Tra le pietre miliari dell'agenda urbana europea, nel 2007 viene adottata il *Leipzig Charter on Sustainable European Cities,* uno strumento che ha rafforzato l'azione delle singole città nella lotta ai cambiamenti climatici che verrà successivamente modificato nel 2020, diventando il *New Leipzig Charter,* in cui sono integrati gli importanti passi avanti compiuti nel corso degli anni, a partire dall'Agenda 2030, l'Accordo di Parigi e il Green Deal Europeo. Inoltre, nel contesto europeo si aggiungono, l'Agenda Urbana per l'UE rafforzando la cooperazione tra i principali organi Europei, i governi nazionali, le autorità municipali e altre parti interessate, il *Green City Accord* in cui un fitto network di sindaci delle principali città europee si impegnano a rendere le città luoghi più inclusivi e verdi e il progetto *LIFE – Programme for Environment and Climate Action,* i cui principali obiettivi sono raggiungere un'economia circolare attraverso l'uso di energie rinnovabili e a zero emissioni.

Nel contesto Europeo, sono molteplici gli esempi da poter riportare. Particolare attenzione è stata dedicata alla regione del Mar Baltico, in cui i Paesi Scandinavi possono considerarsi pionieri in materia di sostenibilità ambientale. Nello specifico, il caso della città svedese di Malmö vede protagonista lo sviluppo del quartiere sostenibile e a impatto zero di *Western Harbour,* sulle orme del progetto pionieristico della città di Stoccolma, in cui la zona di *Hammarby Sjöstad* rappresenta un vero e proprio modello di sostenibilità urbana. Successivamente, il caso esemplare di Copenaghen e del progetto dell'*eco-village,* un nuovo distretto in costruzione nella periferia meridionale della città con l'intento di creare una realtà che inglobi i 17 obiettivi dell'Agenda 2030 per lo Sviluppo Sostenibile.

Dal contesto scandinavo si passa alla Regione Mediterranea, in cui negli ultimi decenni si stanno intensificando le relazioni tra le diverse città che la caratterizzano, unendo i continenti Europeo, Africano e Asiatico in una realtà in cui diventa sempre più centrale combattere gli

impatti invasivi dei cambiamenti climatici, spesso alla base degli intensi processi migratori che interessano la regione. Di spicco, per quanto riguarda la regione Euro-Mediterranea, sono la capitale Catalana di Barcellona, in cui il *Barcelona Green infrastructure and Biodiversity Plan* 2020 propone l'obiettivo di sviluppare infrastrutture sostenibili ed ampliare le zone verdi, già ampiamenti presenti nella città, soprattutto nella forma di viali alberati; la città portoghese di Porto, dove l'iniziativa del *Porto Fifth Façade* vuole aumentare la presenza di edifici verdi attraverso l'utilizzo di *nature-based solutions*. Continuando nel panorama europeo, in Italia la Strategia Nazionale di Adattamento ai Cambiamenti Climatici – SNAC, seppur non contenendo obblighi vincolanti, propone una serie di politiche di adattamento in risposta ai dannosi impatti del cambiamento climatico sul territorio italiano; mentre ancora in fase di sviluppo, il Piano Nazionale di Adattamento ai Cambiamenti Climatici (PNACC) è stato istituito con l'obiettivo di fornire un quadro aggiornato delle attuali tendenze ambientali in Italia, includendo i futuri scenari climatici con l'intento di individuare efficaci azioni di contrasto, strumenti di monitoraggio e di valutazione. A livello nazionale, di rilievo sono il Bologna *Local Urban Environment Adaptation Plan for a Resilient City – Blue Ap* per rendere la città di Bologna più preparata alle difficoltà climatiche ed ambientali, il recente progetto sostenibile che sta sorgendo a Milano, il Nido Verticale, sulle orme del Bosco Verticale, attualmente tra i simboli dell'ecosostenibilità urbana con il merito di aver creato un vero e proprio ecosistema naturale nella città. Nel contesto urbano mediterraneo seppur molto differente da quello scandinavo, i centri urbani sono sempre più coinvolti nel tema ambientale e della transizione energetica-ecologica, oggigiorno al centro della politica europea.

A livello Europeo, esemplare è il caso dei Paesi Bassi, un paese quasi interamente sotto il livello del mare che da sempre ha vissuto e si è sviluppato a stretto contatto con l'acqua, estremamente vulnerabile agli effetti dei cambiamenti climatici, in particolare all'innalzamento del livello dei mari, alluvioni, erosione costale, e molti altri. Per queste ragioni, i Paesi Bassi sono da sempre attivi nel cercare soluzioni resilienti di adattamento e mitigazione a fronte delle severe ripercussioni dei cambiamenti climatici sul paese. Il programma *Room for the River*, portato avanti dal Governo centrale, si propone di sfruttare le risorse idriche, marine e fluviali del paese per controllare i livelli dei fiumi Neerlandesi. In questo contesto, il progetto *Sand-Motors* si propone di arginare l'innalzamento del livello del mare attraverso l'impiego di *nature-based solutions*, in questo caso, l'innalzamento di dune sabbiose lungo le zone più esposte della costa. Centrale nel panorama neerlandese, è certamente il Piano Delta, delineatosi a seguito delle intense alluvioni che colpirono il paese nel 1953, causando numerose vittime e danni. Il primo Programma Delta incorpora i cosiddetti *Delta Works*, un insieme emblematico

di opere e servizi idrici, dighe e piani di protezione costiera, al fine di gestire e prevenire eventuali alluvioni e mareggiate. Il Programma Delta, rinnovato ed ampliato nel corso degli anni, rappresenta una pietra miliare per il paese, oltre che costituire un punto di riferimento per altre realtà in tutto il mondo. Nel contesto Neerlandese sono molteplici le città attive nel prevenire e contrastare i severi effetti del surriscaldamento globale. Ad esempio, nella municipalità di Breda è in corso il progetto *GreenQuays*, con l'intento di sviluppare tecniche verdi - alberi e arbusti nelle pareti delle banchine fluviali, l'utilizzo di più materiali sostenibili e il miglioramento del sistema urbano di drenaggio dell'acqua – al fine di ridurre le coperture di asfalto e migliorare la crescita di piante erbacee, felci e muschi, che possano servire come forme naturali di contrasto ai fenomeni atmosferici che più colpiscono la città, a partire da intense precipitazioni e ondate di calore.

Di rilievo nel contesto urbano dei Paesi Bassi, sono le municipalità di Rotterdam e Amsterdam. Esplorando le soluzioni delle singole città, il caso di Rotterdam viene risaltato dal ruolo centrale che ha nel *Connecting Delta Cities Network* in cui la città svolge un ruolo di leader del programma, lavorando a stretto contatto con realtà globali quali Jakarta, Tokyo, Melbourne, Londra, Venezia, New York, New Orleans, e tante altre. Il *Rotterdam Climate Change Adaptation Strategy*, formatosi nel contesto Europeo della strategia *Green Infrastructure* e il *Rotterdam Climate Proof*, rappresentano iniziative volte a rendere la città più sostenibile e resiliente agli impatti ambientali, oltre che a sviluppare le aree verdi della città. La città di Rotterdam è anche membro – insieme all'Aia – del *Resilient Cities Network*. La città è coinvolta in molteplici iniziative e programmi volta a rendere l'area urbana più sostenibile e verde, e in questo contesto sono simbolici gli edifici galleggianti che sono sempre più presenti in giro per la città, case e uffici (tra cui quello del *Global Center on Adaptation*), la più recente e innovativa *floating farm* e *il floating Pavilion*, divenuto simbolo della città dove il meccanismo di riscaldamento e condizionamento dell'aria si basa sull'energia solare, utilizzata in modo intelligente, i materiali impiegati sono scelti con cura da fonti sostenibili. Infine, va menzionato il ruolo centrale che svolge il porto di Rotterdam nel contribuire a rendere questa città un leader non solo industriale, ma anche nel campo ambientale, sviluppando molteplici programmi volti a diminuire le emissioni generate dalle intense attività portuali.

Infine, il focus si sposta sulla città di Amsterdam, contraddistinta dall'intreccio di canali che le conferiscono il titolo di "Venezia del nord". La città di Amsterdam è cresciuta, nel corso dei secoli, a stretto contatto con l'acqua. Tra gli obiettivi della città, è da considerare quella di diventare una realtà *emissions-free* e a impatto zero entro il 2050, attraverso il programma *Amsterdam Climate Neutral* accompagnato dalla volontà di muoversi verso un'economia circolare e sostenibile

attraverso *l'Amsterdam Circular 2020-2025 Strategy*. Di rilievo nello scenario della capitale Neerlandese, vi è il Progetto RESILIO, il quale prevede di sfruttare in maniera intelligente – e previdente – i tetti degli edifici con impianti e strutture *green-blue*, per poter sfruttare l'accumulo di acqua - approfittando delle precipitazioni atmosferiche - e al tempo stesso mantenere un clima fresco, evitando l'effetto isola di calore urbano che caratterizza sempre più città nei periodi estivi. In questo contesto il progetto RESILIO intende migliorare e sviluppare la tecnologia dei cosiddetti *polder roofs* che si basano sull'accumulo dell'acqua raccolta durante intense precipitazioni, e che una volta raccolta, funge da sistema di irrigazione per la vegetazione e le aree verde dei tetti, dando vita ad un sistema completamente innovativo che permette di evitare l'allagamento stradale e di alleviare la pressione sulla rete fognaria urbana.

Successivamente, nella sezione conclusiva del presente lavoro sono state riportate delle interviste personalmente svolte con dei rappresentanti delle Municipalità di Rotterdam e Amsterdam, attraverso le quali è stato possibile conoscere un punto di vista differente, locale e che potesse includere i punti di forza e le principali debolezze che caratterizzano le due città. In conclusione, è possibile sottolineare che, grazie al sistema statale decentralizzato che caratterizza i Paesi Bassi, le municipalità possono sviluppare autonomamente piani e programmi in materia ambientale – e non solamente – al fine di anticipare e combattere i continui impatti del surriscaldamento globale, inglobando un modello urbano ecologico ed equo, in cui gli adattamenti climatici sono percepiti come una nuova realtà a cui *tutti* dovranno conformarsi. La cooperazione con realtà urbane nazionali ed internazionali che contraddistingue le due città Neerlandesi in quanto centri nevralgici della realtà urbana-regionale della *Randstad Holland*, hanno fatto sì che Amsterdam e Rotterdam potessero rappresentare un modello di riferimento nel campo della sostenibilità, della transizione energetica, dello sviluppo di tecnologie intelligenti, di infrastrutture ecosostenibili e di network sempre più ampi.

In conclusione, soprattutto in luce della recente COP26, ciò che emerge è l'urgenza con la quale la sfida del cambiamento climatico deve essere affrontata. Il presente lavoro vuole dimostrare che tra i tanti attori coinvolti nella lotta contro i cambiamenti climatici, le città possono apportare una svolta decisiva in questa battaglia, sostenute da un sistema di governance inclusivo e policentrico in cui il ruolo di ONG, network, imprese, attori statali e locali, e della società civile non passi inosservato.

TABLE OF ABBREVIATIONS

ACCCRN: Asian Cities Climate Change Resilience Network

AFINUA: Action Framework for Implementation of the New Urban Agenda

ANCI: Associazione Nazionale Comuni Italiani

ANCV: Portuguese National Association of Green Roofs

AOD: Amsterdam Ordnance Datum

ARLEM: Euro-Mediterranean Regional and Local Assembly

BGIBP: Barcelona Green infrastructure and Biodiversity Plan

BLUE-AP: Bologna Local Urban Environment Adaptation Plan for a Resilient City

BSR: Baltic Sea Region

BwN: Building with Nature

CAF: Cancún Adaptation Framework

CBSS: Council of the Baltic Sea States

CCI: Clinton Climate Initiative

CCP: Cities for Climate Protection

CCUS: carbon capture, utilization and storage

CDC: Connecting Delta Cities

CDM: Clean Development Mechanism

CEMR: Council of European Municipalities and Regions

CINEA: European Climate Infrastructure and Environmental Executive Agency

CNCA: Carbon Neutral Cities Alliance

COP: Conference of the Parties

CoR: Committee of the Regions

CWRA: City Water Resilience Approach

DRIFT: Dutch Research Institute for Transition

EESC: European Economic and Social Committee

EbA: Ecosystem-based Adaptation

EC: European Community

ECCP: European Climate Change Programme

ECHR: European Convention on Human Rights

ENoL: European Network of Living Labs

EU: European Union

EUSBSR: European Union Strategy for the Baltic Sea Region

GCA: Global Center on Adaptation

GCoM: Global Covenant of Mayors

GHG: Greenhouse gas

ICLEI: Local Governments for Sustainability

IIED: International Institute for Environment and Development

IPCC: Intergovernmental Panel on Climate Change

IPO: Interprovincial Consultation

IUCN: International Union for Conservation of Nature

LA21: Local Agenda 21

LGMA: Local Governments and Municipal Authorities

LUSH: Landscaping for Urban Spaces and High-Rises

MIT: Massachusetts Institute of Technology

MAP: Mediterranean Action Plan

MW: Milliwatt

MRA: Metropolregio Amsterdam

NAP: National Adaptation Plan

NAPA: National Adaptation Programmes of Action

NAS: National Adaptation Strategy

NGOs: Non-Governmental Organizations

NbS: Nature-based Solutions

OASC: Open and Agile Smart Cities

ONU: Organizzazzione delle Nazioni Unite

PET: Physiological Equivalent Temperature

PNACC: Piano Nazionale di Adattamento ai Cambiamenti Climatici

PNRR: Piano Nazionale di Ripresa e Resilienza

RAS: Rotterdam Adaptation Strategy

RCN: Resilient Cities Network

RCP: Rotterdam Climate Proof

RISA: Rain InfraStructure Adaptation

RIVM: Institute of Public Health and Environment

ROA: Regionaal Orgaan Amsterdam

RUD: Regional Implementation Service

RUMORE: Rural-Urban Partnerships Motivating Regional Economies

RWS: Rijkswaterstaat

SALAR: Swedish Association of Local Authorities and Regions

SCALL: Sistemas de Captación de Agua de Lluvia

SCIS: Smart Cities Information System

SDGs: Sustainable Development Goals

SEA: Single European Act

SMEs: Small- Medium Enterprises

SNAC: Strategia Nazionale di Adattamento ai Cambiamenti Climatici

SNSvS: Strategia Nazionale per lo Sviluppo Sostenibile

SRA*:* Stradsregio Amsterdam

SuDS: Sustainable urban Drainage System

TAPE: Turin Action Plan for Energy

TEU: Treaty on the European Union

TFEU: Treaty on the Functioning of European Union

UBC: Union of the Baltic Cities

UCLG: United Cities and Local Governments

UfM: Union for the Mediterranean

UHI: Urban Heat Island

UIA: Urban Innovative Actions

UN: United Nations

UN-Habitat: United Nations Human Settlements Programme

UNCED: United Nations Conference on Environment and Development

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

UNEP-WCMC: United Nations Environment Programme World Conservation Monitoring Centre

UNFCCC: United Nations Framework Convention on Climate Change

UvW: Union of Water Boards

VNG: Association of Dutch Municipalities

WCDRR: World Conference on Disaster Risk Reduction

WHO: World Health Organization

WRI: World Resources Institute

WWF: World Wildlife Fund

ZEV: Zero-Emissions Vehicles

INTRODUCTION

By now, it is undeniable that climate change represents one of the greatest challenges that humans have to cope with, acting as a stress multiplier that severely impacts the socio-economic and political system of countries, exacerbating critical situations, starting from food shortage and water scarcity, the spread of infectious diseases, migration patterns, regional and international conflicts. The places where the effects of climate change are felt the most are urban areas. They are increasingly being exposed to the rise of average temperatures, heavier precipitations patterns, prolonged periods of droughts, season alterations, flooding, and storm surges. At the same time, it must be stressed that cities are also drivers of climate change, as they represent the main source of CO_2 emissions, due to the intense metropolitan and industrial activities taking place in urban areas. Nowadays, approximately 55 percent of the world population lives in urban areas, a percentage that is expected to increase in the next future, reaching 70 percent by 2050. Thus, it becomes imperative to act *now* to prevent and reduce the acute effects of global warming.

Therefore, the present work proposes to demonstrate the increasing role that urban areas – together with a large number of actors – cover in addressing and fighting environmental hazards, emphasizing that they can make a significant step forward in the fight against climate change, setting the example for those areas that are more vulnerable and fragile in terms of resources and quality of institutions. Starting with a brief delineation of the international environmental regime, this work wants to prove how, to mention the ground-breaking publication of Bloomberg and Pope (2017) *Climate of Hope*, "cities are actually the key to saving the planet."[1]

The first chapter will start delineating the notion of climate change, briefly describing the main impacts on cities and ecosystems, supported by examples such as hurricanes Sandy and Katrina, the costliest natural disasters ever recorded in the U.S.; the tropical cyclones that characterize the South-Pacific region and the intense heatwave that hit Europe in 2021, with the Italian Region of Sicily setting the record temperature of nearly 49 degrees Celsius. Later, the chapter will continue delineating the historical pathway of the international climate change regime, from the first discoveries made throughout the 1960s-1970s, for instance, Rachel Carson's *Silent Spring* and the pioneering *Limits to Growth* by the Club of Rome, in which it is

[1] Bloomberg, M., & Pope, C., (2017) Climate of Hope: how cities, businesses, and citizens can save the planet. New York, St. Martin Griffin Edition.

predicted that environmental deterioration will eventually lead to the collapse of the global economy and resource depletion. In 1972, the work by René Dubois and Barbara Ward, *Only One Earth*, laid the foundation of the 1972's Stockholm Conference, highlighting the impacts of human activities on the ecosystem.

Representing the natural follow-up of Stockholm, in 1992 the United Nations Conference on Environment and Development was held in Rio de Janeiro, resulting in the draft of the United Nations Framework Convention on Climate Change (UNFCCC). Afterward, a paragraph is dedicated to the main steps that led in 1997 to the elaboration of the Kyoto Protocol during the Third Conference of the Parties (COP), with the aim of reducing greenhouse gas emissions by 5 percent compared to 1990 levels. The Kyoto Protocol is based on the principle of common but differentiated responsibilities, by distinguishing less-developed countries from industrialized countries, which are listed in Annex B. The 2015 Paris Agreement stresses – in article 2 - the targets of preserving the global mean temperature rise below 2 ºC above pre-industrial levels and maintaining the temperature rise to 1,5 ºC above pre-industrial levels. At the same time, its main shortcomings will be addressed as well, starting from the hindrances encountered during the official negotiation processes, when in the last hours of the Conference of the Parties, the U.S. called for a last-minute technical change. The chapter will end by stressing the main advancements and alterations that took place in the past years in the field of international climate change regime, from the withdrawal of the U.S. from the Paris Agreement under President Trump, followed by the decision of current U.S President Joe Biden, who officially re-joined the Deal. Also, it will be stated what is expected from the latest COP26 that took place in Glasgow in November 2021 and what was achieved, such as the last-minute decision of India and China – representing the largest emitters of the world – to shift in the drafting of the Glasgow Climate Pact the expression phasing-out coal with phasing-down.

The second chapter will deal more in detail with the purpose of this work, starting with the differentiation of the main impacts of climate change in cities and explaining how, on the other side, urban areas represent the main generators of greenhouse-gas emissions, as a consequence of industrial activities, the transportation system, the energy produced in public and private buildings. This section will also define the essential notions of adaptation and resilience from a more theoretical perspective, starting with the definition of resilience given by Crawford S. Holling, i.e., "[…] the ability of these systems to absorb changes of state variables, driving

variables and parameters, and still persist."[2] As opposed to resilience, the notion of vulnerability is necessary to understand the level of exposure of cities to environmental hazards. An example in this context will be provided by the vulnerability assessment carried out by the UN-Habitat (United Nations Human Settlements Programme) in the city of Pakse in Laos, located on the Mekong River. At the same time, it will be shown the case of Curitiba, Brazil, which by prioritizing smart transit, development of greenery, environmental sustainability, and social inclusion, has effectively addressed – and anticipated – the main effects of climate change, paving the way for a less congested, sustainable and equitable reality.[3] After the notion of resilience, a section will be dedicated to the concept of adaptation, representing a vital tool in the fight against climate change, exploring the role of adaptation in the international environmental regime, from the Kyoto Protocol to the Paris Agreement. An interesting form of adaptation is given by nature-based solutions, where the use of ecosystem-based adaption includes the use of green-blue infrastructures, the restoration of natural ecosystems acting as natural buffers against environmental threats. Here, multiple ecosystem-based adaptation measures will be mentioned, from the recovery plans after Hurricane Katrina in New Orleans and the smaller realities in San Salvador (El Salvador) and Kingston (Jamaica), to Abu Dhabi and the Chinese case of sponge cities. After the description of resilience and adaptation, a section will be dedicated to the common aspects of these two complementary notions, demonstrating how they represent two sides of the same coin. The second chapter will also define the concept of environmental governance, stressing the importance and the necessity of a multi-layered model of governance that will enable cities to cope with the complex reality of climate change. In this regard, an important role is played by international and regional networks of cities, with the main task of connecting urban areas, helping them to share knowledge, experience, and expertise on a wide range of topics. The international networks of C40 Cities, the Local Governments for Sustainability (ICLEI), the Resilient Cities Network will receive special attention. The last point of the chapter will illustrate the international urban regime, in particular the Local Agenda 21, the UN Agenda 2030 on Sustainable Development and the relative 17 Sustainable Development Goals (SDGs), the New Urban Agenda, and the high participation of cities and mayors to the latest COP26 held in Glasgow in 2021.

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[2] Holling C. S., (1973) *Resilience and Stability of Ecological Systems*, Annual Review of Ecological Systems, Vol. 4.

[3] Gustafsson, H., & Kelly, E. A., (2016) Developing the Sustainable City: Curitiba, Brazil, as a Case Study. In: Brescia, R., & Marshall, J. T., (Eds.) *How Cities Will Save the World: Urban Innovation in the Face of Population Flows, Climate Change and Economic Inequality*. Abingdon, New York, Routledge.

Subsequently, the third chapter will be focusing on the European Union environmental framework, by studying the role of environmental matters in the European legislation, reporting the latest EU initiatives, from the European Green Deal to the European Climate Law, setting the ambitious goal of becoming the first climate-neutral continent by 2050. Also, the European Union's 2013 Adaptation Strategy, which aims at supporting member states in the drafting and implementation of efficient adaptation policies. This action should be supported by more prompt and targeted measures at the national and urban levels. Indeed, many actions are explored through the EU-based platform Climate-ADAPT, reporting data, policies, and adaptation measures at the regional, national, and urban levels. Amongst the most important achievements of the European urban agenda, there is the Leipzig Charter on Sustainable European Cities, adopted in 2007 to strengthen the action of cities in the fight against climate change, which subsequently will become in 2020 the New Leipzig Charter, incorporating the important landmarks of the 2030 Agenda, the Paris Agreement, and the European Green Deal. In addition, the Urban Agenda for the EU, the Green City Accord, and the LIFE - Programme for Environment and Climate Action will be addressed throughout the chapter. In the European framework, several case studies will be tackled thoroughly. In particular, the sustainable and green development that characterized the Scandinavian cities of Malmö, Stockholm, and Copenhagen since the 1990s will be explored through the examples of the Western Harbour district in Malmo and the ongoing UN17 eco-village in Copenhagen; also, actions and initiatives in the urban centers of the Mediterranean region will be reported, starting with Barcelona, Porto, and the Italian cities of Bologna and Milan, where the Vertical Forest set the example for the expansion of green roofs and facades, reunifying the natural ecosystem with the urban landscape.

The fourth and last chapter will be focusing on the specific case of the Netherlands, as a low-lying and delta area. The section will start by addressing the most important national policies to contrast climate change, with special emphasis on the Delta Porgramme, developed after the intense flooding that hit the country in 1953. Starting from the Delta Plan, a series of Delta Works started to develop with the intention of strengthening the relations with water-related hazards through a series of engineering works, the expansion of green dikes, natural interventions, and water barriers. Emblematic is the Room for the Rivers Programme and the Sand Motor, to tackle major flooding and storm surges. Across Dutch cities, climate adaptation actions will be explored in the municipalities of The Hague, Utrecht, Breda.

Later, the attention will be shifting to the Municipalities of Amsterdam and Rotterdam. In the case of the Dutch capital, several local plans and policies will be explored, such as the

Amsterdam Climate Neutral, the Amsterdam Circular 2020-2025 Strategy, the Clean Air Action Plan. In addition, the RESILIO project will be examined thoroughly. This project is centered on green-blue infrastructures being developed throughout the city in the rooftops of both private and public buildings, in an innovative scheme where rainwater is retained in a system of water storage that will be serving to irrigate the plants, trees, and vegetation installed in the roofs, to alleviate the pressure on the sewerage network when intense precipitations occur, and to mitigate the common urban heat island effect that characterizes the city during the hot season. Attention will also be given to the local network Amsterdam Rainproof, where the motto "every drop counts" highlights the principles at the basis of the organization, with the purpose of supporting Amsterdammers in adapting through local initiatives, events, seminars, workshops, festivals, to make the city climate- and water-resilient.

The Municipality of Rotterdam is widely known for the prominence of its industrial port, the first in the European Union, in which numerous environmental and carbon-free plans are being developed to reduce the CO_2 emissions, generated by intense industrial and harbor activities. After a brief description of Rotterdam as a port city, the section will proceed to highlight the role of Rotterdam as leading delta city in the C40 Network Connecting Delta Cities, in which the Municipality had the opportunity of developing permanent relationships with numerous cities, such as New Orleans, Jakarta, New York, Ho Chi Minh City, Venice, sharing its experiences and knowledge as a delta city, supporting the development of adaptation plans and initiatives in New York, New Orleans (in the aftermath of Hurricane Katrina), and Ho Chi Minh. Rotterdam is also a member - with The Hague - of the Resilient Cities Network. The Municipality is involved in many programs aiming at helping the city in a green and sustainable transition toward climate neutrality. Indeed, Rotterdam is working hard to expand green-blue infrastructures, reaching this year 21,5 hectares of green areas. A pioneering action launched by Rotterdam is the development of floating buildings around the city, with the floating houses along the Maas River, the floating Pavilion, which represents a landmark of sustainability for the city, the first floating farm based on an ecological and circular economy. The very last section of the chapter is divided into two parts. In the first one, I will develop two interviews I had – through email correspondence - with Rotterdam Chief Resilience Officer Arnoud Molenaar and – through a phone interview - with Amsterdam Rainproof Community Manager Lisette Heijke, allowing me to have a more straightforward approach and comprehension of the two different, yet enlightening realities of Amsterdam and Rotterdam. In conclusion, a brief consideration of the Dutch case in the European Framework will be provided, positioning Rotterdam and Amsterdam in the broader context of the Randstad Holland Region.

CHAPTER 1. THE EVOLUTION OF GLOBAL CLIMATE CHANGE

1. Defining and introducing global climate change: a stress multiplier

In the last decades, the scientific community has increasingly focused its attention on studying the mechanisms and functioning of our climate, with specific regard to climatic and environmental changes. For some time now, the truth is emerging on the anthropogenic influence on our planet's climate and temperatures, strictly related to fossil fuels, deforestation, and livestock activities, which is causing the release of greenhouse gases (GHG) into the atmosphere.[4] Indeed, the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and the latest IPCC's report *Climate change 2021. The Physical Science Basis* pointed out that anthropogenic emissions of green-houses gases are at their highest levels driven by economic and population growth, demonstrating human activities' influence on the climate system, with severe and rife impacts on our society and on the ecosystem.[5,6] A series of studies by acclaimed economists, international summits, and EU-commissioned studies demonstrated that immediate and firm action to reduce greenhouse gases would have higher benefits than the costs and damages that could derive from climate change. These costs are estimated to increase in proportion to the delay with which containment measures were adopted. In fact, devastating economic and social repercussions - both in underdeveloped countries and in developed ones - have been registered in the last decades as a result of environmental changes.[7] Therefore, climate change should be considered as a comprehensive issue, spreading from being a scientific, technological problem to an economic and ethical one. If emissions of greenhouse gases continue, further warming and long-lasting alterations in the climate system will persist, increasing the likelihood of severe and irreversible impacts for ecosystems and human livelihood. Indeed, climate change will amplify existing risks and creating new ones. Hazards

[4] Giuffrida, R & Amabili, F., (2018), *La tutela dell'ambiente nel diritto internazionale ed europeo*, Torino: Giappichelli Editore, p. 227

[5] IPCC, (2014), *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland, IPCC, p. 2

[6] IPCC, (2021) Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., Zhai, P., Pirani, A., et al. (eds.)]. In Press, p. 4

[7] Giuffrida, R & Amabili, F., *op. cit.*, pp. 229-230

are unevenly distributed and are usually higher for disadvantaged people and communities in countries with different levels of development.[8]

Nowadays, due to unpredictable weather and climate trends, many significant consequences are affecting human health. As the planet warms, regions of the world will suffer new climate-related health menaces. The effects of climate change on human security and livelihoods vary by geographical location and socioeconomic status, affecting elders, children, and the ill. [9] Among the tangible effects of climate change, extreme weather events emerge, such as the growing strength of cyclones and hurricanes. By any measure, 2017 was a historic hurricane season for the Caribbean, the Gulf of Mexico, and the U.S., with the destructive appearance of hurricanes Harvey, Irma, and Maria, the costliest and major hurricanes after 2005's Katrina. Losses of over 315 billion USD were recorded primarily because of Harvey, Irma, and Maria. These patterns indicate the rising risk of extreme weather events in the era of global warming.[10] More recently, the latest hurricane, Ida, generated vast wind, storm surge, and inland flood into the Mid-Atlantic and Northeast on September 1 of this year, being recognized as one of the costliest U.S. mainland hurricanes on record (adjusted on a nominal and inflation basis).[11]

As regards of the South-Pacific region, it experienced two category-five cyclones in 2020. Tropical Cyclone Yasa was one of the most intense ever recorded in the South-West Pacific with catastrophic consequences especially in the Fiji islands.[12] Indeed, Yasa was soon followed by cyclone Ana in January 2021, causing the desruction of essential water, sanitation and hygen services to local families, schools and health care facilities.[13] As for the South American region, abundant rainfall associated with influence from La Niña[14] caused extensive flooding in Chile, Colombia, and along the Amazon River in the Brazilian state of Amazonas throughout May and June 2021.[15] Other consequences of a warming planet is melting of the glaciers, warming and acidification of the oceans, and rise in sea levels. Indeed, according to the IPCC fifth

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[8] IPCC, *op. cit.*, pp. 56, 64

[9] Singer, M., (2019), *Climate change and social inequality: the health and social costs of global warming*. Abingdon, Oxon; New York, Ny: Routledge, An Imprint Of The Taylor & Francis Group, p. 11

[10] *Ivi*, pp. 12-13

[11] Aon Benfield, (2021), *Global Catastrophe Recap: August 2021*, s.l.: Aon, p. 5

[12] WMO, (2021), *State of the Global Climate 2020*, Geneva, Switzerland; pp. 28-29

[13] UNICEF, (2021). *Over 30,000 cyclone affected Fijian children and their families to receive support under new UNICEF - Government of New Zealand partnership*. [Online] Available at: https://www.unicef.org/pacificislands/press-releases/over-30000-cyclone-affected-fijian-children-and-their-families-receive-support-under

[14] La Niña is a climate pattern for which oceanic temperatures in the Equatorial Pacific are unusually cold. It is the opposite effect of El Niño, which is characterized by unusually warm ocean temperatures in the Equatorial Pacific. See also https://www.pmel.noaa.gov/elnino/what-is-la-nina

[15] Aon Benfield, (2021), *Global Catastrophe Recap: June 2021*, s.l.: Aon, p. 6

assessment report, due to sea-level rise, coastal systems and low-lying areas will increasingly endure submergence, flooding, and erosion throughout the 21st century and beyond. To better explain, climatic and non-climatic drivers affecting coral reefs will erode habitats, increase coastline exposure to waves and storms, damaging environmental habitats important to fisheries and tourism.[16]

Finally, extreme high temperatures events are the main cause of mortality related to weather. It is widely acknowledged that cities and urban areas, as home to more than 54 percent of the world's population and representing the living core of economic activities, are particularly vulnerable to heatwaves.[17] More specifically, vulnerable groups like the elderly, the sick, the poor, pregnant women, and infants represent the biggest target of heatwaves. As climate change unfolds and the Earth is warming, life in urban centers is becoming critical and unsustainable, especially for the aforementioned categories. Heat islands arise when a large portion of the natural land is covered by built surfaces – roads, buildings, parking lots. These constructions trap solar radiation during the daylight hours and release it at night. Therefore, cities create their own climates. Moreover, as the human population continues to urbanize and consume more fossil fuel, the health, social and economic repercussions of urban overheating emerge as a grave threat to the well-being of city residents worldwide.[18] Just last August, it has been recorded the hottest day ever in Europe, near the Italian city of Syracuse, in Sicily. The temperature of 48.8 degree Celsius exceeded the 48 degrees set in Athens in July 1977.[19] After a brief description of what it is intended with climate change, its impacts on the environment and on human lives, this chapter will illustrate the historical path of the international climate change regime, lingering on the most significant steps such as the Kyoto Protocol and the most recent Paris Agreement, trying to underline what it is expected to achieve in the upcoming years.

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[16] IPCC, *op. cit.*, p. 67

[17] Ellena, M., Breil, M. & Soriani, S., (2020). The heat-health nexus in the urban context: A systematic literature review exploring the socio-economic vulnerabilities and built environment characteristics. *Urban Climate*, 34, pp. 2, 14

[18] Singer, M., *op. cit.* pp. 21-22

[19] Pianigiani, G. (2021). *Sicily Registers Record-High Temperature as Heat Wave Sweeps Italian Island.* The New York Times. [online] 12 Aug. Available at: https://www.nytimes.com/2021/08/12/world/europe/sicily-record-high-temperature-119-degrees.html#:~:text=The%20Italian%20island%20of%20Sicily%20may%20have%20set

2. The historical path of the international climate change regime

Already in the early 1960s, scientists ascertained that atmospheric concentration of CO_2 – representing the main greenhouse gas – were undoubtedly increasing. Furthermore, in the mid-1980s, experts recognized that anthropogenic emissions of other trace gases – methane and nitrous oxides amongst all – also contribute to the greenhouse effect, making the problem even more critical than originally believed.[20] As a consequence, the growth of scientific knowledge was crucial in laying a foundation for the development of public and political interest. A small group of environmentally oriented western scientists collaborated to foster the climate change issue on the international arena, for instance by helping to transform and publicize the emerging scientific knowledge about the greenhouse effects through workshops, articles, reports, and conferences.[21] Indeed, in 1962 the publication of Rachel Carson's *Silent Spring* signed the beginning of Earth politics and modern environmental movements. Throughout the 1960's and the 1970's, in Europe and America, emerged the concern that economic growth, western consumerism, and the related unsustainable lifestyle demands were threatening the ecological balance and security of the planet. In 1972, microbiologist René Dubos and economist Barbara Ward wrote *Only one Earth*, serving as the basis for the 1972 UN conference on the Human Environment held in Stockholm. During the same year, the milestone *Limits to Growth* was published by the Club of Rome, attempting to combine optimism concerning the human potential to innovate and overcome demographic-environmental problems.[22]

The development of the climate change regime between the late 1980s and early 1990s followed the path of environmental activity, which started in 1987 with the discovery of the stratospheric "ozone hole" in the Antarctic region and the publication of the Brundtland Commission report, *Our Common Future*, and culminated at the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, representing the follow-up to 1972 Stockholm.[23] During the 1972 Stockholm Conference three important non-binding instruments were adopted; a) the Declaration of the United Nations Conference on the Human Environment containing twenty-six principles; b) the Action Plan with 109

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[20] Bodansky, D., (2001), *The history of the Global Climate Change*. In: U.L. a D.F. Sprinz, ed. International Relations and global climate change. Cambridge, MA: MIT Press, p. 24, 26

[21] *Ivi*, pp. 26-27

[22] Blewitt, J. (2018), *Understanding Sustainable Development*, London: Routledge, An Imprint Of The Taylor & Francis Group, pp. 8-9

[23] Bodansky, D., *op. cit.*, p. 23

Recommendations, and c) a Resolution on institutional and financial arrangements.[24] In general, the Conference was deemed to have been successful, and according to one commentator "Stockholm enlarged and facilitated the means toward international action previously limited by inadequate perception of environmental issue and by restrictive concepts of national sovereignty […] There were significant elements of innovation in the redefinition of international issues, the rationale for co-operation, the approach to international responsibility, and the conceptualisation of international organisational relationships." [25] Moreover, amongst the most significant achievements of the Stockholm Conference, the creation of the United Nations Environment Program and the adoption of Principle 21. It is thanks to the UNEP that important regional and international development – such as the EU environmental protection rules and the creation of the OECD Environment Committee – and treaties were possible. For instance, the UNEP Regional Seas Program that comprises over thirty regional environmental treaties, the 1985 Vienna Convention, the 1987 Montreal Protocol on the protection of the ozone layer and the 1989 Basel Convention on hazardous waste.[26]

Between the 1980's and the 1990's, governments started to become more involved in the environmental agenda, but nongovernmental actors still had extensive influence. In this sense, the IPCC played an important part. Established by the World Meteorological Organization and the United Nations Environment Program in 1988, the Intergovernmental Panel on Climate Change soon produced its first assessment report in 1990, evaluating the global warming and the changing climate. In the same period, are placed the 1988 Toronto conference – recommending cutting global emissions of CO_2 by 2005 - the UN General Assembly resolution of the same year on the protection of global climate for present and future generations, the 1989 Hague Summit and the Noordwijk ministerial meeting, and the 1990 Second World Climate Conference.[27] Soon in the 1990s there was the increasing necessity to strengthen the role of international environmental law. Indeed, a convention on climate change modeled on the 1985 Vienna Ozone Convention quickly arose.[28] In December 1990 the UN General Assembly, supported by the UNEP and the WMO, established the Intergovernmental Negotiating

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[24] United Nations, (1972), *Report of the UN Conference on the Human Environment*, UN Doc. A/CONF.48/14/Rev. 1, p. III

[25] Caldwell, L.K., (1996), *International Environmental Policy: from the twentieth to the twenty-first century*, Duke University Press, pp. 55, 60 in Sands, P., et al., 2018, *Principles of International Environmental Law*, Cambridge: Cambridge University Press, p. 31

[26] Sands, P., et al., 2018, *Principles of International Environmental Law*, Cambridge: Cambridge University Press, pp. 34, 60

[27] Bodansky D., *op. cit*., p. 28

[28] *Ivi*, p. 31

Committee for the preparation of a new for a Framework Convention on Climate Change containing "appropriate commitments" that "should be completed prior to the United Nations Conference on Environment and Development in June 1992 […]."[29] After five sessions between 1991 and 1992, the FCCC was adopted in May 1992, and the Convention entered into force only two years later when the threshold of ratification was reached. The Agreement represents a careful compromise between developed and developing countries, striving to achieve a common framework effective for the fight against climate change.[30]

In June 1992, the UN Conference on Environment and Development, widely known as Earth Summit, produced several agreements: the Rio Declaration, the Convention on Biological Diversity where it is affirmed that maintaining biological diversity is the key to the planet's overall health; a non-binding Statement on Forest Principles and the non-binding Agenda 21 for sustainable development, where the environmental meets social and economic concerns.[31] More specifically, the Rio Declaration includes twenty-seven Principles, providing a framework for the development of environmental law at the national and international level, representing not only a step forward the 1972 Stockholm Declaration, but also an important and valuable benchmark for governments.[32]

2.1 From Kyoto to Paris: international response to a warming Planet

It was 1995, when during the first Conference of the Parties (COP-1) in Berlin, the *Ad Hoc Group on The Berlin Mandate* was established aimed at negotiating a new legal instrument that integrated what was already stated in the UNFCCC. Indeed, during the 1997 COP3, the Kyoto Protocol was adopted.[33] The Protocol represented the first international environmental law agreement containing binding provisions for states – in particular, for developed countries. For this agreement to come into force, a ratification by 55 countries was required. Moreover, these nations should have been responsible for at least 55 percent of the emissions of anthropogenic origin. Indeed, the Kyoto Protocol contains severe provisions for its parties. Given the different economic and developmental nature of each country, the Protocol's initiative to differentiate

[29] United Nations General Assembly, (1990). *A/RES/45/212: Protection of global climate for present and future generations of mankind*. 21 December 1990, A/RES/45/212. Available at: https://research.un.org/en/docs/ga/quick/regular/45
[30] Bodansky, D., *op. cit.* p. 32
[31] Blewitt, J., *op. cit.*, pp. 12-13
[32] Sands, P., *op. cit*., p. 45
[33] Franceschelli, F., (2019), *L'impatto dei cambiamenti climatici nel diritto internazionale,* Napoli: Editoriale Scientifica, p. 240

the amount of each state's gases emission - by limiting them when deemed exaggerated - represented a hindrance during the negotiating process and later for the entry into force.[34] In early 2001 President George W. Bush announced that the U.S. – representing the main greenhouse gas emitter – would not ratify and support the Kyoto Protocol, questioning the entire future of it. [35] Later, thanks to the seventh Conference of the Parties held in Marrakech, the remaining countries compromised on mechanisms for implementing obligations under the Protocol. The 2001 Marrakech accords reflected an important breakthrough on many of the critical negotiating concerns, and a clear sign that the global community was ready to commit to the Kyoto Protocol, even without the support of the United States.[36] Amongst the most innovative – yet controversial – aspect of the Kyoto Protocol there are the flexibility mechanisms, allowing the parties to purchase credits representing greenhouse gas reductions, to bear milder economic burdens. The first mechanism is the Joint Implementation, in which, according to Art. 6 of the Protocol, "any Party included in Annex I may transfer to, or acquire from, any other such Party emissions reduction units […]"[37]. Secondly, the Clean Development Mechanism (CDM) is regulated in Art. 12 of the aforementioned, permitting Annex I [38] parties to gain emission reductions credits and "[…] to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3 […]".[39] The last mechanism, addressed by Art. 17, is the International Emission Trading. Through the IET – operating through the cap-and-trade rule - it has been established a carbon market, in which the countries subject to gas emissions limits (listed in Annex B of the Protocol) may perform transactions concerning the greenhouse gas emission quotas.[40]

It is widely agreed that the Protocol is likely to leave an enduring imprint on the global climate regime. Even if the Kyoto Protocol is ultimately terminated[41], it has significantly contributed to the international response to the climate change issue. It created a global system capable of pursuing precious experiments, generating valuable experience – that will lay the

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[34] Ivi, p. 241

[35] See Transcript, Bush Press Conference at White House, 29 March 2001. Available at https://georgewbush-whitehouse.archives.gov/news/releases/2001/03/20010329.html

[36] Sands, P., et al., *op. cit.*, p. 285

[37] Kyoto Protocol to the United Nations Framework Convention On Climate Change, art. 6 (1)

[38] Annex I is referring to the list of countries outlined in the UNFCCC that were undergoing the process of transition to a market economy. See United Nations Framework Convention on Climate Change, 1992

[39] Kyoto Protocol, art. 12(3)(b)

[40] Franceschelli, F., *op. cit.*, p. 244

[41] The Kyoto Protocol predicted two different commitment periods: the first one between 2008 and 2012 and the second between 2013 and 2020, after the Doha amendment. See Franceschelli F., 2019, *L'impatto dei cambiamenti climatici nel diritto internazionale*, Napoli: Editoriale Scientifica, p. 242

foundation of the Paris Agreement – and building capacity to report, and regulate GHG emissions. Arguably, the Kyoto Protocol attempted to do too much too quickly. Yet its originality, complexity, and ambition embody a proof to the determination and creativity of its negotiators and will leave an enduring legacy in the international climate regime. [42]

The Paris Agreement, conceived as a follow-up of the Kyoto Protocol, represents a remarkable case of environmental law achievement. The New York Times has defined the Agreement as a "landmark"[43], the Guardian "the world's greatest diplomatic success"[44] while the Arabic news channel Al-Jazeera described it as "historic."[45] Certainly, it is too soon to speak of the Paris Agreements in terms of success in solving the environmental crisis, however, it represents an outstanding accomplishment in multilateral diplomacy and an important environmental landmark. Yet, criticisms towards the Agreement have not been spared, starting from the lack of legally binding obligations. During the negotiations process taking place in Paris in December 2015, major changes occurred in the final stage of the meeting, when the U.S. strongly opposed to legally binding mitigation in contrast with the EU – in coalition with Latin American countries and most Island states – striving to achieve a mandatory environmental agreement.[46] Ultimately, it was the U.S. that undermined mitigation commitments for developed countries, as in the last minutes – literally the last minutes - before the final session that approved the agreement on December 12, the U.S. firmly requested a single word change: "Developed countries "should" rather than "shall" undertake economy-wide quantified emission reductions."[47] The start of the meeting was postponed for 90 minutes to address this last-minute deadlock, and the EU and the G77 unwillingly accepted, leading to a less legally binding action after what was publicly defined a "technical correction."[48]

Also, in the aftermath of the agreement, scientists and experts demanded for a more specific definition of its target, asserting the limit to global warming to no more than 2°C above pre-industrial levels and ideally closer to 1.5°C, but when does the post-industrial era start, and

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[42] Bodansky D., et al., (2017), *International Climate Change Law*, Oxford: Oxford University Press, p. 207

[43] Davenport, C., (2015) *Nations Approve Landmark Climate Accord in Paris*, The New York Times [online] Available at: https://www.nytimes.com/2015/12/13/world/europe/climate-change-accord.paris.html

[44] Harvey, F., (2015), *Paris Climate Change Agreement: The World's Greatest Diplomatic Success,* The Guardian [online] Available at: https://www.theguardian.com/environment/2015/dec/13/paris-climate-deal-cop-diplomacy-developing-united-nations

[45] Bazley, T., (2016), *The Paris Agreement and why it matters*, Al-Jazeera, [online] Available at: https://www.aljazeera.com/news/2016/11/4/the-paris-climate-agreement-and-why-it-matters

[46] Dimitrov, R. S., (2016) The Paris Agreement on Climate Change: Behind Closed Doors, *Global Environmental Politics*, 16(3), p.3

[47] Ibid

[48] Ibid

which temperature measurement is the target built on?[49] In fact, while the Paris agreement lack specific policies, there are indeed numerous free market answers available: There is wide consensus among economist that a carbon tax is the most efficient way to curb carbon emissions and pollution.[50] And as Tanuro (2016) points out, the agreement does not establish a year for global GHG emissions to start diminishing, or an annual ratio of decline, or a date indicating when mankind should stop employing fossil fuels. What we have, is simply: "Parties aim to reach global peaking of greenhouse gas emissions as soon as possible […]" indicated in Article 4.[51] Furthermore he added that "the fact that the Agreement does not mention 'energy transition' is not a regrettable lapse in generally good text, but proof by omission that the negotiators have chosen to bet on geoengineering instead of confronting fossil capital"[52] especially if considering that the notion of "energy transition" is currently at the core of the political agenda of most countries.

The road that led us to the 2015 Paris Agreement commenced with the 2007 COP13 in Bali, where the Bali Action Plan delineated a process aimed at a sustainable and healthy long-term cooperation between States. Later, the 2009 COP15 was held in Copenhagen, but the achievement of a post-Kyoto settlement did not come into light. Instead, a non-binding political agreement emerged, the Copenhagen Accord, aimed at cutting global emissions and maintaining global temperatures increase below 2 degrees Celsius.[53] In 2010, the Cancun Accords were adopted, and the Green Climate Fund was established. However, a deal that would regulate the post-Kyoto period was not reached and neither was it during the 2011 COP16 held in Durban. Nevertheless, the Durban Platform for Enhanced Action was instituted with the intent to shape the agreement that will govern, coordinate, and boost the next generation of climate actions.[54] In 2012, the Doha COP18 produced the Doha Amendment which, as stated earlier, extended the Kyoto Protocol commitment period from 2013 to 2020.

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[49] Nuccitelli, D., (2018) *Climate scientists debate a flaw in the Paris climate agreement*, The Guardian [online] Available at: https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/mar/28/climate-scientists-debate-a-flaw-in-the-paris-climate-agreement

[50] Nuccitelli, D., (2015) *The Paris agreement signals that deniers have lost the climate wars*, The Guardian. [online] Available at: https://www.theguardian.com/environment/climate-consensus-97-per-cent/2015/dec/14/the-paris-agreement-signals-that-deniers-have-lost-the-climate-wars

[51] Tanuro, D., (2016) *Specter of geoengineering haunts Paris climate deal, Climate & Capitalism*. [online] Available at: https://climateandcapitalism.com/2016/01/25/the-specter-of-geoengineering-haunts-the-paris-climate-agreement/

[52] Ibid

[53] Copenhagen Accord, para. 2, Available at https://unfccc.int/process-and-meetings/conferences/past-conferences/copenhagen-climate-change-conference-december-2009/cop-15

[54] Rajamani, L., (2012), *The Durban Platform for Enhanced Action in the Future of the Climate Regime*, ICLQ, 61 (2), p. 501

However, numerous countries responsible for large amounts of GHG emissions countries such as Canada, Russia, and Japan, did not take part in the second commitment period of the Protocol, rendering it almost ineffective. Finally, during the 21st Conference of the Parties, after four years of negotiating since the Durban Platform, the Paris Agreement was adopted, a legally binding treaty on climate change matters, based on the UNFCCC with the purpose of substituting the Kyoto Protocol starting from 2020. [55]

The requirements for the Paris Agreement to enter into force was the ratification by 55 UNFCCC parties representing at least 55 percent of global emissions. Unlike Kyoto that spent seven years to enter into force, the Paris Agreement became effective in a record time, on 4 November 2016. As stated in Article 2, the purpose of the Agreement is "[…] to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty."[56] The main objectives of the Agreement are enounced in art. 2(a), attempting to "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels […]".[57] Arts. 2(b) and 7 control adaptation measures whereas Art. 4 disciplines mitigation actions, at the very core of the Agreement. Accordingly, the Nationally Determined Contributions (NDCs) clarified in art. 4(2), represent the efforts made by each country in reducing GHG emissions. NDCs foresee the voluntary action of states to engage at the national level in proper actions and adaptation measures for the fight against climate change.[58] The Agreement contains legal obligations for its parties, which pledged to cooperate following the principle of equity and common but differentiate responsibilities, in a framework of transparency and control – with each other and at the domestic level. Moreover, the Preamble - and not the articles – includes, even if in a very generic manner, the need to preserve and guarantee basic human rights in coordination with climate actions.[59]

The main shortcomings of the Agreement can be represented, for instance, by the lack of information on the production of energy by fossil fuels, a serious source of environmental changes. Secondly, the lack of a proper mechanism of compliance, that monitors the fulfilment of the legal obligations contained in the Agreement, a role covered, according to Art. 14, to the Conference of the Parties. Lastly, the exclusion from the Accord of economic sectors at high

[55] Franceschelli, F., *op. cit.*, pp. 250-251
[56] Paris Agreement, art. 2
[57] *Ivi*, art. 2(a)
[58] Franceschelli, F., *op. cit.*, p. 254
[59] *Ivi*, p. 256

climatic impacts, for instance air and sea transportation, represent another flaw.[60] Despite the weaknesses, it is undeniable that the Paris Agreement symbolizes a milestone in the fight against climate change and just as Kyoto was in the 1990s, Paris denotes a winning of the international community, embodying the willingness to cooperate and to be involved in the struggle against global warming, adopting for the very first time a bottom-up approach. The Agreement also represents an enormous success for the United Nations and from an intergovernmental perspective, being the first – and by far, the most important – international multilateral agreement of the 21st century.[61]

3. The International climate agenda: where are we standing now?

The first Conference of the Parties after Paris was held in November 2016 in Marrakech. Nothing relevant came out from the COP22. Serious criticism was aimed towards several countries – U.S., China, Italy, and Germany - for their NDC's national measures were considered inadequate and ineffective. Moreover, the fear of a change of direction from the U.S. was dreaded when moving from the Obama to the new Trump administration. Indeed, on 28 March 2017 U.S. President Donald Trump signed an executive order annulling numerous climate initiatives undertaken during the Obama presidency.[62] In June 2017, Trump announced its intention to withdraw the U.S. – among the first polluters and emitters in the globe - from the Paris Agreement and in 2020, the country was released from the commitments of the Accord. [63] However, right after the 2020 Presidential elections, the newly elected Joe Biden quickly reinstated the U.S. to the Paris Agreement, putting an end to a period where the U.S. was considered a pariah on the international stage, with the Trump administration's refusal to address one of the most challenging threats of this century.[64]

In December 2019 Madrid hosted the COP25, generally considered to be a failure, and not only from a diplomatic perspective. The COP25 should have dealt with new science and technologies, define business on climate finance, and raising trust and ambition. On one side, wins on gender, agriculture and capacity building were reached. Yet, decisions on carbon

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[60] Postiglione, A., (2016) *L'accordo di Parigi sul clima del 2015*, pp. 63-84 in Franceschelli, *op. cit*., p. 257
[61] Giuffrida, R., & Amabili, F., *op. cit*., p. 241
[62] *Ivi*, p. 244
[63] McGrath, M., (2020) *Climate Change: US formally withdraws from Paris Agreement*, BBC News, [online] Available at: https://www.bbc.com/news/science-environment-54797743
[64] Milman, O., (2021) *Biden returns US to Paris climate accord hours after becoming president*, The Guardian [online] Available at: https://www.theguardian.com/environment/2021/jan/20/paris-climate-accord-joe-biden-returns-us

market remained unclear, leaving doubts, and glaring gaps to be fixed and addressed at COP26, expected in Glasgow in 2020.[65] UN Secretary General António Guterres declared its disappointment with the results of the COP25 declaring its determination to work for better results to be achieved in 2020.[66] Of course, due to the COVID-19 pandemic, the 26th COP was deferred to November 2021 and represents now one of the most expected events of the year.

In the run up to COP26 the UK – as president and host of the event - is working with every nation to reach settlement on how to tackle climate change. More than 190 world leaders are expected to arrive in Glasgow, Scotland, together with tens of thousands of negotiators, government representatives, businesses, NGOs, and citizens, for twelve days of talks. Amongst the most important aspects to be discussed, there are more ambitious emission reduction targets (NDCs); the need for countries — in particular, LDC — to protect and restore ecosystems, make infrastructure and agriculture more resilient; keep the promise to raise at least 100 billion USD per year in climate finance. Lastly, to finalize the Paris Rulebook, containing the rules and recommendations to implement the Paris Agreement. Despite the many opportunities, it is widely deemed that the international community is not acting fast enough. To avoid this crisis, countries need to join forces urgently, and in this sense, it is essential for the COP26 to be decisive and effective.[67] In the aftermath of the official meetings, representatives of nearly 200 countries adopted the final draft of the deal, pledging to develop further actions to cut emissions, more frequent updating and reports on progress, and complementary funding for low and middle-income countries.[68] Yet, generalized dissatisfaction stemmed from the lack of stronger commitments to reduce GHG and failure to harmonize on "loss and damage" finance for countries more exposed to climate change.[69] The final 11-page text, the Glasgow Climate Pact, declares the need to reduce greenhouse-gas emissions and carbon dioxide emissions, which must fall by 45 percent from 2010 levels by 2030 for global warming to be kept at 1.5 °C above pre-industrial levels and countries acknowledged these urgencies, and also accepted to report on progress at an annual rate: for the first time in a COP draft, nations agreed to start reducing

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[65] Chandrasekhar, A., (2019) *The UN climate talks ended in deadlock. Is this really the best the world can manage?* The Guardian, [online] Available at: https://www.theguardian.com/commentisfree/2019/dec/21/un-climate-talks-deadlock-cop25

[66] UNFCCC, (2019) *Statement by the UN Secretary-General António Guterres on the outcome of COP25* [online] Available at https://unfcc.int/news/statement-by-the-un-secretary-general-antonio-guterres-on-the-outcome-of-cop25

[67] UN Climate Change Conference UK, (2021) *COP26 Explained*, Available at: https://ukcop26.org/uk-presidency-/what-is-a-cop/

[68] Masood, E., & Tollefson, J., (2021) "Cop26 Hasn't Solved The Problem": Scientists React To Un Climate Deal, *Nature*. Vol. 599, p. 355.

[69] Ibid

coal-fired power and to begin to eradicate subsidies on other fossil fuels. [70] Yet, the first hindrances started to appear. The world's largest and third-largest carbon polluters, China and India respectively, as well as the globe's top two coal-burning countries, drew a line at the last minute about speeding the coal phase-out, in a move that angered and upset climate change-vulnerable nations: rather than a phase-out of coal, India and China pushed to change the expression in "phased-down."[71] The last-minute reconsideration by India and China recalled the way the U.S. changed its positions on legally-binding commitments during the COP21 negotiation process, and pushing the delegation to replace the expression "shall" with "should."

The Glasgow deal also encompasses commitments from some countries to put an end to deforestation and cut methane emissions, "and a pledge from the financial sector to move trillions of dollars of investments into companies that are committed to net-zero emissions."[72] However, previous experiences indicate that these promises will still not be adequate to confine global warming to 2 °C above pre-industrial levels - the target outlined in the 2015 Paris climate agreement; while University of Kent conservation biologist's Charlie Gardner, declared that more-radical action is necessary, for instance through the elimination of fossil-fuel production more rapidly.[73] Lastly, although COP26 generated a final deal, the conference drew criticism as many representatives of different non-governmental groups were prevented from participating in the discussions, logistical difficulties caused the exclusion of people with disabilities and a lack of representatives from the Global South, those most affected by climate change, was due to shortage of affordable accommodation and the inability and difficulty to access the meetings.[74,75]

In conclusion, despite the COP26 was deemed to be the last chance to reverse the course of global warming, it proved inefficient under many points of view, being described as "the most exclusionary COP ever," and "Global North greenwash festival".[76] It is the turn of single states, international organizations, non-state actors, local authorities to come forward and try to make a real change.

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[70] Ibid
[71] Niranjan, A., (2021). *COP26: World leaders fail to honor climate pledge,* DW [online] Available at: https://www.dw.com/en/cop26-world-leaders-fail-to-honor-climate-pledge/a-59812348
[72] Masood, E., & Tollefson, J., *op. cit.* p. 356
[73] Ibid
[74] Ibid
[75] Meredith, S., (2021) COP26 sharply criticized as the most 'exclusionary' climate summit ever, CNBC [online] Available at: https://www.cnbc.com/2021/11/05/cop26-sharply-criticized-as-the-most-exclusionary-climate-summit-ever.html
[76] Ibid

CHAPTER 2. GLOBAL CLIMATE CHANGE THROUGHOUT RESILIENT CITIES

1. Climate change and cities: victims and perpetrators

The present chapter outlines the role of global cities in the fight against climate change, underlining how they represent part of the problem as well as part of the solution in this struggle, also referring to Sustainable Development Goal number 11, "making cities and human settlements inclusive, safe, resilient, and sustainable."

The section will continue to emphasize the importance of multi-layered governance and the need to avail of new bottom-up approaches to better address environmental changes.

Furthermore, adaptation measures and plans will be explored as a necessary and multidimensional approach.

It is undeniable that cities represent the main contributors to climate change. According to UN Human Settlement Programme, cities generate over 60 percent of greenhouse gas emissions while consuming 78 percent of the world's energy, despite accounting for less than 2 percent of the Earth's surface.[77]

In 1940, only one in eight people lived in an urban center, while one in 100 resided in a city with a million or more inhabitants. By 1980, approximately one in three people was an urban resident and one in 10 a city dweller.[78] At the turn of the 21st century, 46 percent of the urban population lived in cities.[79] Today, 55 percent of the world's population lives in urban centers, a portion that is deemed to increase to 68 percent by 2050. Forecasts show that urbanization, the gradual shift of the human population from rural to urban areas, combined with the overall growth of the global population, could add another 2.5 billion people to urban areas by 2050, with close to 90 percent of this expansion taking place in Asia, Africa.[80] Today, the most urbanized regions cover North America, where 82 percent of the people live in urban areas, 81 percent in Latin America and the Caribbean, Europe with 74 percent, and Oceania with 68

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[77] United Nations, (n.d.) *Cities and Pollution*, [online] United Nations. Available at: https://www.un.org/en/climatechange/climate-solutions/cities-pollution

[78] United Nations, (1987) *Report of the World Commission on Environment and Development: Our Common Future*

[79] *World Urban Population 1960-2021.* [online] Available at: https://www.macrotrends.net/countries/WLD/world/urban-population

[80] Unite Nations, (2018) *68% of the world population projected to live in urban areas by 2050, says UN*, [online] United Nations Department of Economic and Social Affairs Available at: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

percent. The level of urbanization in Asia is around 50 percent. In contrast, Africa is predominantly rural, with 43 percent of its inhabitants living in more densely populated areas.[81]

As the world inevitably continues to urbanize, sustainable development progressively depends on effective management of urban growth, especially in low and middle-income countries where the pace of this process is expected to be the fastest. Many countries will face severe challenges in meeting the needs of their growing urban populations, going from housing, transportation, the energy system to employment and basic services – education and health care.[82] The rush to the city has had dire consequences not only for human well-being, but especially for the ecological system.[83] The effects of urbanization and climate change are converging in a dangerous way, threatening to have unprecedented impacts on the quality of life, on economic and social stability. However, alongside the risks posed by this interaction, there is an equal set of opportunities. Cities – with a higher concentration of people, buildings and infrastructures – are likely to face the most severe impacts of climate change. At the same time, this concentration of people and infrastructure will make them vessels for innovation, where strategies to promote new energy sources, reduce GHG emissions (mitigation policies) and improve response mechanisms to reduce vulnerability to climate change impacts (adaptation measures).[84] Urban areas operate as engines of change by altering the environment and exploiting energy and natural resources both within and outside their geographical area.

Simultaneously, urban centers are affected by these transformations, facing the challenges of providing safe and adequate living spaces and infrastructure in a context of limited resources.[85] The impacts that global warming has on urban areas are now well documented and at this point, undeniable. Cities may face serious complications in providing even the most basic services to their dwellers due to climate change that alters water supplies, ecosystem goods and services, energy provision, industries, and services in cities around the globe. Such impacts are likely to spread unevenly among regions and cities affecting the most vulnerable areas – such as less-developed countries – reinforcing and exacerbating existing inequalities between people.[86] Among the most severe geographic trends and variations in physical climate change

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[81] Ibid

[82] Ibid

[83] Cash, C., (2016) Good governance and strong political will: Are they enough for transformation? *Land Use Policy*, volume 58, p. 545

[84] UN-Habitat, (2011) *Global Report on Human Settlements 2011: Cities and Climate Change*, London, Earthscan, p. 1

[85] Boyd, E. & Juhola S., (2015) Adaptive climate change governance for urban resilience, *Urban Studies*, 52(7), pp. 1234-1235

[86] Un-Habitat (2011) *op. cit.* p. 65

facing urban settlements, are sea-level rise, tropical cyclones, heavy precipitation events, drought and extreme heat events.[87] Increase in mean sea-level rise has been reported around the world in recent decades with significant regional variations, recorded in the central Pacific region, the northeast Indian Ocean and the North Atlantic, along the US coast.[88] Therefore, coastal cities are the most exposed to the numerous direct and indirect effects of sea level rise, including storm flooding, inundation, coastal erosion, increased salinity in estuaries and coastal aquifers, obstructed drainage. As ecosystems, such as wetlands, mangrove swamps and coral reefs, provide a natural protection for coastal areas, damage or loss of these resources will inevitably worsen the dangers faced by coastal areas and cities.[89] Coastal areas and low-altitude cities are particularly vulnerable to this threat.

Thailand's capital, Bangkok, is only between 1.6 and 6.5 feet above sea level and in 2017 the city was hit by intense rains that escalated into severe flooding, hitting at least 20 districts across the city. Moreover, the Yom River – which flows through the city – overflowed, affecting 10,000 families.[90] Ho Chi Minh City is situated in the Saigon and Dong Nai rivers area, in southern Vietnam. The main challenges facing the city are urban flooding due to heavy rainfall and inadequate drainage capacity, further impaired by rapid urban development on low-lying swampland, extreme weather events and consequently, continuous sea-level rise. [91] Another example is Copenhagen, the capital of Denmark, located on the coast of the Øresunds region – which connects the North Sea with the Baltic Sea – particularly vulnerable to rising sea-levels, warmer weather and more extreme events in the future.[92] Furthermore, tropical cyclones and heavy precipitations events, can also cause disrupting consequences in the urban context. For instance, during the 2017 hurricane season, the Gulf coast of Texas experienced extreme rainfalls, inundating the Houston area during Hurricane Harvey.[93] As a result, floods and landslides are among the costliest and damaging disasters, posing critical difficulties to city planners. The risk of flooding is expected to increase on the Atlantic coast and in Europe[94] – and the catastrophic floods that occurred in Western Europe during the summer are the latest example. In this sense, as of 2008, the Netherlands is one of the most exposed countries in

[87] Ibid
[88] UN-Habitat, (2011) op. cit., pp. 65-66
[89] Ibid
[90] Singer, M., (2019) *Climate Change and Social Inequality: The Health and Social Costs of Global Warming*, Abingdon, Oxon, New York, NY, Routledge, p. 15
[91] C40 Cities, (2016) *Climate Change Adaptation in Delta Cities*, p. 10
[92] Ibid
[93] Singer, M., *op. cit.*, p. 14
[94] UN-Habitat, (2011) *op. cit.*, p. 68

Europe, with almost one third of the country located below average sea level.[95] Another emblematic example is given by Dhaka, the capital of Bangladesh, a city situated between four flood-prone rivers, amid the Himalaya Mountain range and a body of water from which violent cyclones and inland floods are generated. The inconvenient position of the megacity – between 6 and 42 feet above sea level –melting glaciers and snow in the Himalayas and heavy rainfall, will lead to an increasing incidence of flooding in Bangladesh in general and in the delta region – including Dhaka.[96]

While it is undeniable that the Earth is heating up, cities are becoming increasingly warmer at a faster rate than in other parts of the planet. [97] Cities, unlike rural areas, generate their own climate: the greater presence of built surfaces result in heat island effects. And as the process of urbanization continues to deepen, more fossil fuel will be employed and the health, social and economic impacts of summer urban warming will worsen, threatening the well-being of city dwellers. [98] Of course, the effect of heatwaves is not uniform across cities. The physical configuration of a city, its population size and density, and the structural characteristics of the built environment all influence the impact of the urban heat-island effect. Extreme heat events will negatively impact the most vulnerable groups – the elderly, women and children – by increasing energy demand and impacting water supply.[99] However, many cities around the globe are addressing these menaces through cooling techniques and strategies – cool and green roofs, for instance, will help absorb solar radiation and reduce the emission of GHG. [100] Strictly connected to urban heatwaves, drought leads to hydrological shortcomings that affect land resources and the production system, ultimately leading to water and food insecurity.[101]

Consequently, the physical structure of urban areas is altered by climate change and events – affecting infrastructure, roads, the network of buildings and therefore, the welfare and livelihoods of its dwellers. Significant damage to residential and commercial structures – especially in the case of low-elevation coastal areas – is expected to increase with the incidence of risks associated with climate-change. For instance, Miami (US) is among the cities the most exposed to climate catastrophes and will remain so until 2070, with exposed assets that will

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[95] VanKoningsveld, M., et al., (2008), Living with Sea-Level Rise and Climate Change: A Case Study of the Netherlands, *Journal of Coastal Research*, 24(2), p. 367-379

[96] UN-Habitat, (2008) *State of the World's Cities 2008/2009: harmonious cities*, London: Earthscan, p. 152

[97] Singer, *op. cit.*, p. 21

[98] Ivi, p. 22

[99] UN-Habitat, (2011) *op. cit.*, p. 69

[100] C40 Cities, (2016) *Cool Cities,* pp. 5-6

[101] UN-Habitat, (2011) *op. cit.*, p.70

increase from approximately $400 billion to over $3.5 trillion.[102] Serious consequences will also affect transportation systems, resulting in travel hindrances and delays. The energy system will also have to undergo changes, as the effects of urban heat-islands will generate an increase in energy demand. Climate change will also affect energy production and distribution. Across Africa, hydroelectric power generation is likely to be limited by the more frequent occurrence of drought.[103] Furthermore, water supply and water security are increasingly threatened by environmental changes. Due to intense precipitation and flooding, the quality of clean water may decrease – for instance, due to increased salinity of the water. These episodes could lead to an increase in contamination and disease, affecting the most vulnerable, especially in developing countries. In general, the increasing frequency and intensity of extreme climatic episodes and slow-onset changes will amplify the vulnerability of urban economic assets.[104]

The damage to the economic sector is accompanied by serious repercussions on the inhabitant's livelihood. The most affected will be the urban poor, indigenous groups, the elderly, children, and women, the latter, most involved in the fight against climate disasters and at the same time those most excluded from environmental governance. There is high evidence that one of the many reasons people and ethnic groups decide to migrate, is environmental conditions. Rising sea-levels, flooding, prolonged drought, coastal erosion, and the numerous climate disasters can lead to permanent displacement of people, leading to internal and international migration.[105]

As stated earlier, cities are not just the target of climate catastrophes, as cities themselves contribute climate change patterns by stimulating green-house gas emissions. Therefore, it is vital to understand to what extent urban areas contribute to climate change. First, a range of activities – consumed within city boundaries– are associated with cities and their functioning, causing GHG emissions. Second, measuring the emissions of different cities provides the basis for effective inter-urban comparison and cooperation. Third, the increasing percentage of the Earth's population living in towns and cities, coupled with the concentration of economic and industrial activities, means that they need to be at the frontline of mitigation and adaptation policies.[106] Furthermore, it is important to underline the difference between the analysis of GHG emissions based on production and consumption. Most calculations of cities' contribution to

[102] Ivi, pp. 70-71
[103] Ivi, p. 72
[104] Ivi, p. 74
[105] Ivi, p. 84
[106] Ivi, p. 33

climate change have focused on emissions from activities taking place within its spatial boundaries.

An alternative approach considers emissions related to the consumption patterns of city dwellers, providing us with an alternative framework by suggesting appropriate ways to reduce the ecological impact of cities and their inhabitants.[107] The combustion of fossil fuels is the main source of greenhouse gas emissions and is widely used for electricity, heating, cooling, cooking, transportation, and industrial production. In fact, the type of fuel used to generate electricity has a serious impact on greenhouse gas emissions.[108] Transportation is also a major contributor to air pollution and carbon dioxide emissions on a global scale, accounting for nearly 64 percent of total oil consumption and 27 percent of all energy use.[109]

In the spatial area of cities, commercial and residential buildings are closely associated with GHG emissions. They are accountable for direct emissions – onsite combustion of fuels – indirect emissions, linked to public electricity, street lighting and other urban activities; and emissions associated with embodied energy – construction materials used for buildings.[110] The IPCC's Fifth Assessment Report stated that more than 50 percent of emissions are attributable to industrial activities.[111] Many of these, such as iron and steel, chemicals and fertilizers, petroleum refining, cement, pulp, and paper, are energy-consuming in their functioning.[112] Furthermore, despite accounting for only a small fraction of global emissions – three percent of total emissions –waste generation rates have increased in recent years, particularly in developing countries. Finally, urban areas can have an impact on agriculture emissions, changes in land-use and forestry. The urbanization process can involve direct changes in land use, flowing into built-up areas. Moreover, the consumption patterns of wealthy urban dwellers can influence the type of agricultural activities that take place.[113]

Since ancient times, urban planning has been characterized by geographical features and settlement along vast bodies of water – seas, lakes, and rivers – has historically been a vital

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[107] Ibid

[108] Ivi, pp. 38-39

[109] United Nations, (2021) *Global transportation at a crossroads: UN Conference to advance action on zero emission vehicles, boost economy and reduce inequalities*. [online] United Nations. Available at: https://www.un.org/en/desa/sustainable-transport-conference-2021

[110] UN-Habitat, (2011) *op. cit*., p. 42

[111] IPCC, (2014) *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 784

[112] UN-Habitat, (2011) *op. cit.*, p. 43

[113] Ivi, p. 44

economic and strategical factor, stimulating the demographic growth of cities.[114] Urbanization and climate change are sources of challenges and opportunities for both development and the environment. The impacts of increased GHG emissions and global warming are currently manifesting more strongly and more frequently, with negative repercussions on urban infrastructures and city residents. Therefore, the need to adapt and mitigate the effects of global climate change is *now* more urgent than ever.[115] Many governments, cities and policy makers are already active in the fight against climate change, promoting resilient solutions to reduce their ecological footprint, moving from green and sustainable urban infrastructures, vulnerability and disaster assessment systems, nature-based solutions and so on. Therefore, the next paragraph will address the concept of resilience by exploring case studies of resilient cities and concluding with the notion of vulnerability and vulnerability assessment.

1.1 Understanding resilience and resilient solutions in global cities

"Resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables and parameters, and still persist."[116] This is how resilience is defined by Canadian ecologist Crawford S. Holling in his 1973 seminal paper *Resilience and Stability of Ecological Systems*. In a later work, Holling et al., emphasized how resilience in an ecological-system is related to: (a) the magnitude of shock that the system can assimilate, (b) the degree to which the system is able to re-organize itself and (c) the ability of the system to build capacity for learning and adaptation.[117] At the same time, vulnerability represents the other aspect of resilience: whenever a social or ecological system loses resilience, it becomes vulnerable to change that previously could have been absorbed.[118] Indeed, in a resilient system, change has the potential to create opportunities for development and innovation. In a vulnerable system even the smallest change could be terrible and the less resilient the system, the less the ability of institutions and societies to adapt and shape revolutions.[119] The notion of resilience is applicable to a wide range of

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[114] Ivi, p. 3
[115] Ivi, p. 14
[116] Holling C. S., (1973) *Resilience and Stability of Ecological Systems*, Annual Review of Ecological Systems, Vol. 4, p. 17
[117] Folke C.., et al. (2002) Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformation, A*MBO A Journal of the Human Environment,* 5(31), p. 7
[118] Kasperson J. X. & Kasperson R. E. (ed.), (2001) *Global Environmental Risk*. United Nations University Press/ Earthscan London as cited in Folke C.., et al. (2002) Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformation, A*MBO A Journal of the Human Environment,* 5(31), p. 13
[119] Folke C., et al., *op. cit*., p. 13

sectors, however Holling's exploration of resilience – sided by the concept of stability – is often considered as the origin of modern resilience theory, efficiently using the term "resilience" to designate the ability of an ecological system to continue functioning or to "persist" – when changes occur, and not necessarily remaining the same.[120]

There is vast literature on the notion of resilience. However, it is widely accepted that cities need to become resilient to a wider range of shocks to prepare for climate threats and efforts to increase climate change, resilience needs to be boosted with efforts to promote urban development and sustainability.[121] According to Leinchenko, urban resilience commonly refers to the ability of a city or urban system to withstand a wide set of trauma and stress. Urban resilience studies are anchored in a wide range of literature, which is accordingly divided into four categories: urban ecological resilience, urban hazards and disaster risk reduction, resilience of urban and regional economies, and promoting resilience through governance and urban institutions. Each of them highlights distinct aspects of urban resilience and each converges on different components of cities and urban networks.[122] Lastly, the governance and institutions branch of urban resilience focuses on how resilience thinking can influence the development of improved governance mechanisms to promote adaptation to climate change.[123] Leichenko concludes affirming that urban resilience is generally considered a positive trait. Yet, the literature review conducted by Meerow et al. slightly disputes this belief. For many, urban resilience is understood as planning the ability to return to a "normal" or regular state after a shock.[124]

However, as Meerow et al. recall by citing the works of Gunderson & Holling (2002), Scheffer, et al. (2001), and Wu & Wu, (2013), this is not always true, as some conditions – such as poverty, dictatorship, fossil fuel dependence – can be extremely undesirable and unsustainable, yet quite resilient.[125] In this sense, there is a wide difference. In consideration of this, there is a wide difference between the equilibrium and non-equilibrium view of resilience. The former defines resilience as the ability of a system to return to its stable equilibrium point

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[120] Folke, 2006; Klein et al., 2003; Meerow & Newell, 2015 cited in Meerow et al., (2016), Defining urban resilience: A review, *Landscape and Urban Planning*, Vol. 147, p. 40

[121] Leichenko, R., (2011) Climate change and urban resilience, *Current Opinion in Environmental Sustainability*, Vol. 3, p. 164

[122] Ibid

[123] Ibid

[124] Meerow, S., et al., (2016) Defining urban resilience: A review, *Landscape and Urban Planning*, Vol. 147, p. 44

[125] Ibid

after a shock, whereas the latter views resilience as the ability of a system to adapt and adjust to changing internal or external processes.[126]

It is evident, from Holling's (1973) initial definition of resilience that he supported the non-equilibrium view, shared by many scholars. In fact, a city that promotes a non-equilibrium view – in its projects and planning – accepts that city processes are dynamic, interdependent, and cooperative, acting as a living organism. An example is given by New York City in the aftermath of Hurricane Sandy, demonstrating the fact that New York failed to comply with the non-equilibrium view, demonstrating its inability to adapt and adjust in extreme weather events.[127]

Therefore, an efficient plan for a climate resilient city should increase the ability of a city to survive a climate change-related shock, as well as to learn and change in the event of external environmental disasters. In this sense, what can be helpful are efficient assessments of environmental risk and vulnerability. The IPCC defines vulnerability as "the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt."[128] Vulnerability assessment tools are vital for policy makers, crucial to understanding the degree of vulnerability their city is exposed to. It helps determine a) the city's exposure to current and future climate change situations and hazards (e.g., sea-level rise, extreme weather events, temperature fluctuations); b) the city's sensitivity i.e., the degree to which people, infrastructures and sectors are shaped by events linked to climate change and opportunities; c) the adaptability of the city, the degree to which people, infrastructures, institutions, and sectors are capable to adapt to environmental threats, becoming more resilient to climate change.[129] An example of vulnerability assessment – conducted by the UN-Habitat – is given by the town of Pakse in Laos, along the Mekong River, characterized by a tropical climate and affected by south-east monsoons.[130] The city is constantly hit by extreme weather events and global warming is intensifying seasonal changes, whiles wet seasons are getting wetter, dry seasons

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[126] Cartalis, C., (2014) Toward resilient cities – a review of definitions, challenges and prospects, *Advances in Building Energy Research*, 8(2), p. 260

[127] Ibid

[128] IPCC, (2014) Climate Change 2014: *Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge, U.K., New York, U.S., Cambridge University Press., p. 1048

[129] Ingram, J., & Hamilton, C., (2014) *Planning for Climate Change: A strategic, value-based approach for urban planners*, UN-Habitat, p. 45

[130] UN-Habitat, (2014) *Pakse, Lao People's Democratic Republic - Climate Change Vulnerability Assessment*, UN-Habitat, p. 2

are getting drier. The hottest month – April – is expected to get even hotter and annual precipitations are becoming more intense, causing severe flooding, sometimes even twice a year. [131]

The town inhabitants are severely affected in every sphere of their lives: their homes rendered inaccessible; public infrastructures – in particular public health services – severely affected; their businesses and industries strongly hit, hindering their financial revenues. At the same time, Pakse dwellers try to support each other in these difficult times, using boats in case of intense flooding, building stilts to support their homes, developing simple yet efficient adaptive skills. Of course, major environmental problems continue to affect the city and its inhabitants. Greater adaptation and resilient measures should be adopted, such as hard engineering works – flood walls, stormwater storage systems – enhanced flood warning systems. Awareness needs to be spread among citizens, more human and technological capital is required to improve infrastructure and avoid greater consequences – for instance, improving the water management system for cleaner water, their homes, and buildings.[132] Many other Asian cities are characterized by an informality that exemplifies many aspects of the municipality – from livelihood activities to housing. For example, among the symbols of informal settlements is the slum. Asian cities are home to a population of 550 million slums, two-thirds of which reside in the five most populous Asian countries –Bangladesh, China, India, Indonesia, and Pakistan.[133] In this context, the Asian Cities Climate Change Resilience Network was launched in 2008 by the Rockefeller Foundation in partnership with other organisms – academics, NGOs, governmental, international and regional organizations. The network attempts to catalyze attention, financial support and action to build climate change resilience for poor and vulnerable persons in Asian cities, not just in times of environmental shock or threats, but every day. The ACCCRN proved to be a significant experiment and "learning lab" for the Foundation, its beneficiaries and partners, to increase capacity-building in cities, to better understand and implement resilience solutions to the often-overwhelming impacts and stress of climate change.[134]

When describing the concept of resilience, it is imperative to address the case of Curitiba, Brazil, widely considered one of the first green and resilient cities. With 1.8 million inhabitants,

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[131] Ivi, p. 5
[132] Ivi, p. 23
[133] Kumar, C. B., (2013) Climate Change and Asian Cities: so Near yet so Far, *Urban Studies*, 50(7), p. 1459
[134] The Rockefeller Foundation, (n.d.) *Asian Cities Climate Change Resilience Network (ACCCRN) Initiative Final Evaluation Report*. [online] Available at: https://www.rockefellerfoundation.org/report/acccrn-final-evaluation-report/

Curitiba is the seventh largest city in Brazil and its reputation for success is due to the efforts of former mayor Jamie Lerner. Under the leadership of Lerner, Curitiba has become an award-winning model of urban sustainability, through the implementation of several strategies. For instance, the creation of new green spaces; the implementation of structural axes to facilitate the flow of traffic and create access to decentralized mixed-use centers – commercial outlets, libraries, internet facilities; the design and development of the *Cidade Industrial de Curitiba* in the southwestern part of the city; the pedestrianization of Rua das Flores over the course of a weekend.[135] With over 50 square meters of green space per capita, Curitiba is widely regarded as a model of green and sustainable city. In addition, its numerous parks serve as an ecological function.[136]

Fig. 1 - Curitiba Municipal Botanical Garden (from: Curitiba City Hall)

One of its parks, Saõ Lourenço, is located between a river floodplain. Before the recreational area was created in 1972, the area was a *favela*. During the annual winters, the valley basin would flood, carrying the waste from the slum into the water supply, contaminating it. Urban planners – including Mayor and architect Jamie Lerner – build low-income housing away from the valley, converting the land into a park, giving poorer dwellers better shelter and livelihoods and an ecological green area, where instead of noisy lawnmowers, the sheep grazes the grass.[137]

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[135] Blewitt, J., *op. cit.*, p. 255-256

[136] The Ecologist. (n.d.) *Curitiba: the Greenest city on Earth*. [online] Available at: https://theecologist.org/2014/mar/15/curitiba-greenest-city-earth

[137] Frontline World, (n.d.) *Brazil – Curitiba's Urban Experiment, December 2003*. [online] Available at: http://www.pbs.org/frontlineworld/fellows/brazil1203/parks.html

However, one of the most successful ideas is the implementation of an Integrated Transportation Network, which employs fast biarticulated buses and iconic tubular bus shelters and a clearly designated route [138], the Bus Rapid Transit system in Curitiba, the greatest leading example of sustainable transport in a city. More than 60 percent of Curitiba's citizens depend on the bus system, which functions like an actual above-ground subway.[139] Another successful plan – under the Green Exchange Programme – developed in 1989 by Lerner's assistant Nicolau Klüppel, was to exchange trash for tokens. Today, 90 percent of the city participates in its recycling programme, making sure that nowadays the inhabitants of Curitiba recycle 70 percent of its garbage. To report the British newspaper The Guardian:

> […] first as planners, then a mayor – Lerner would develop a radically different visions for Curitiba: "it was a change in the conception of the city. Working, moving, living leisure … we planned for everything together. […] Curitiba was the first city that, in its first decisions, brought everything together."[140]

The case of Curitiba shows how the collaboration between urban planning and sustainability has created an eco-city whose planning and infrastructures have become a model in all cities of the world. Nowadays, cities are exposed to an increasing number of challenges: from poverty and crime to the new threats of the Covid-19 pandemic to the acute effects of climate change. The development of resilience measures is now more compelling than ever, becoming more sustainable in everyday life. It is widely recognized that resilience should not be limited to a system's ability to return to its original state after a shock, but also to adapt and adjust to changing processes. Moreover, plans for an effective and functional resilient city should especially consider the sustainability, changes and balances of society, identifying vulnerable groups and their disproportionate exposure to environmental changes. [141]

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[138] Blewitt, J., *op cit.*, p. 255

[139] Green Cities Time, (n.d.) *Green City: Bus Rapid Transit and Urban Planning in Curitiba.* [online] Available at: https://www.greencitytimes.com/curitiba/

[140] Alder, D., (2016) Story of cities #37: how radical ideas turned Curitiba into Brazil's "green capital." [online] The Guardian. Available at: https://www.theguardian.com/cities/2016/may/06/story-of-cities-37-mayor-jaime-lerner-curitiba-brazil-green-capital-global-icon

[141] Cartalis, C., *op. cit.*, p. 264

1.2 Multi-layered governance and resilient cities: a new perspective

For many years, cities have been governed through traditional top-down regulations and other governance instruments – mainly, building codes and zone legislation – implemented by central governments. This approach worked well for some years. However, it did not function properly for environmental problems, avoiding addressing urban sustainability and resilience – climate change mitigation and adaptation actions.[142] The traditional role that nation-states have played in the global environmental governance arena has focused on the negotiation, formation, and eventual implementation on a national level. However, since the 1990s, it has been known that the nation-state is not the only player on the global stage.[143] Indeed, the centrality of non-state actors - NGOs, environmental groups, private and public actors, businesses, citizens, communities, and political actors – is evident when it comes to shaping and representing the interests on nation-states, shaping the formation of the regime, and contributing to the implementation of the regime's objectives.[144]

The role of non-state actors in multilateral international negotiations on climate matters has increased in the last decades. For instance, during the 1994 Convention to Combat Desertification, the role of NGOs in a participatory, bottom-up approach emerged in the text of the Convention, demonstrating successful and positive cooperation between nation-states and non-state actors.[145] According to the definition of the United Nations, more specifically in the UNDP strategy paper on governance, governance refers to "the exercise of political, economic, and administrative authority to manage the affairs of a country at all levels. It includes the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, fulfill their obligations and mediate their differences." [146]

The more environmental threats are getting worse, the stronger is the need to implement a multi-layered, multi-actor system of governance: now, more than ever, it is imperative to significantly improve our understanding of environmental governance. The participation of national governments is required, but not sufficient, as state action is considered imperfect without civil society, NGOs, regional and international organizations. We need "good

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[142] Van Der Heijden, J., (2017) Urban sustainability and resilience in: Drahos, P., (ed) *Regulatory Theory: foundations and applications*, Acton, London. Anu Press, p.725

[143] Bulkeley, H. & Betsill, M. M., (2003) *Cities and Climate Change: Urban sustainability and global environmental governance*, Abingdon, Oxon, Taylor and Francis, Ann Arbor, Michigan Proquest, pp. 9-10

[144] Ivi, p. 11

[145] Ivi, p. 12

[146] UNDP (United Nations Development Programme) (1997) *Governance for sustainable human development: A UNDP policy document*. Available at: https://www.parlicentre.org/Governance.php

governance", an umbrella term that designates enduring and positive changes in accordance with the six key principles of openness, participation, accountability, effectiveness, coherence and civic peace, which can involve civil society action as well as major public sector reforms.[147] Good governance also as an "enabling tool" to reduce urban poverty, improve service provision, fighting crime and violence, enhancing civic participation and promote economic performance.[148] Referring to Oran Young (2013), an environmental governance expert, Blewitt stresses the importance of improving our understanding of ecological governance as we move deeper into the Anthropocene. In his study *Sugaring off: enduring insights from long-term research on environmental governance,* Oran Young seeks to ascertain the most important results of a research started in the early 1970s, on the roles that institutions play in the governance of human-environmental relations. In this essay he starts by drawing up a series of ten propositions on environmental governance, applicable in all contexts.

He then sets forth five propositions that prioritize international environmental governance. In the penultimate section, Young underlines a series of challenges that he believes are essential for a comprehensive understanding of environmental governance.[149] Summarizing the ten propositions on environmental governance, the author emphasizes the essential message by stating that "Environmental and resource regimes play major roles in determining the extent to which societies are able to solve a wide range of problems arising in human-environment relations."[150] International environmental governance is considered as "a proper subset of the overarching category of environmental governance."[151] The propositions discussed are not sufficient for a broad comprehension of environmental governance. Young reasons on the most suitable way to face environmental governance in the Anthropocene. It is clear that we are facing a series of environmental problems for which our existing social capital in the realm of environmental governance is not sufficiently adapted.

We are dealing with extensive and rapidly shifting problems (e.g., climate change) that cannot be solved merely through the intricate processes of negotiating and regulating multilateral environmental agreements.[152] Young stresses the importance of being prepared for

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[147] Batterbury, S.P.J. & Fernando, L.J., (2006) Rescaling Governance and the Impacts of Political and Environmental Decentralization: An Introduction, *World Development*, 34(11), p. 1853

[148] Blewitt, J., *op. cit*., p. 151

[149] Young, O. R., (2013) Sugaring off: enduring insights from long-term research on environmental governance, *International Environmental Agreements: Politics, Laws and Economics*, Vol. 13, p. 88

[150] Ibid

[151] Ivi, p. 96

[152] Ivi, pp. 99-100

the new era of the Anthropocene by improving the ability to design efficient environmental and resource regimes. We are increasingly operating in a world where there is a need to engage in applied institutional analysis, *i.e.*, to produce results that can help us to cope with the difficulties of environmental governance that are becoming a matter of significant public interest.[153] Young finally concludes by underlining the equal importance of both practice and analysis for engaging in applied institutional analysis, stressing that the basic idea he wanted to demonstrate is that institutions are important determinants of human-environment relations, considering that they normally operate simultaneously with a range of other drivers and actors.[154]

Subsequently, British geographer Harriet Bulkeley emerged as a leading scholar in the relationship between climate change and cities, focusing her attention on climate change policy and environmental governance.[155] In one of her latest essays, *Climate changed urban features: environmental politics in the Anthropocene city,* Bulkeley confirms the vital importance of multi-level climate governance as a supporting analysis tool yet containing considerable omissions. She continues by stating that "Accounts of multilevel governance tend to focus on public authorities as at the heart of both hierarchical and horizontal governance arrangements, with more limited attention to the multiple forms of agency and modes of governing through which urban climate politics takes place."[156] In *Government by experiment? Global cities and the governing of climate change*, Bulkeley and Castán Broto, seek to demonstrate an approach that looks beyond the classic institutional understanding of urban climate governance by engaging with the ways government is achieved through social and technical practices – i.e., through experiments on climate change to intervene in urban socio-technical systems, aimed at responding to the needs of mitigation and adaptation of urban climate change.[157] Early research on environmental governance, focusing on analyzing climate policy commitments and frameworks established by local governments while understanding urban climate governance in the post-Paris era, entails a wider conceptualization of governance that unravels how an array of urban experiments are governed in the city.[158]

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[153] Ivi, p. 102

[154] Ivi, pp. 87, 102

[155] Bear, H. A. & Singer, M., (2018) *The Anthropology of Climate Change: An Integrated Critical Perspective*, London, New York, Earthscan from Routledge, p. 203

[156] Bulkeley, H. (2021) Climate changed urban features: environmental politics in the Anthropocene city, *Environmental Politics*, 30(1-2), pp. 267-268

[157] Bulkeley, H., & Castán Broto, V., (2013) Government by experiment? Global cities and the governing of climate change, *Transactions of the Institute of British Geographers*, 38(3), p. 361

[158] Acuto, M., & Smeds, E., (2018) Networking Cities after Paris: Weighing the Ambition of Urban Climate Change Experimentation, *Global Policy*, 9(4), pp. 550-551

Assuredly, experimentation represents a relevant characteristic of the urban climate change governance of the post-Paris era. Understanding this new method of governance as something other than traditional local climate policy is necessary to channel its potential for global environmental governance.[159] Finally, the governance of climate change occurs through forms of intervention in cities – experiments – rather than being restricted to policies and plans. In this sense, experiments are not second to urban climate governance, but represent the critical means through which governing is achieved.[160] Bulkeley (2013) states that "in essence, a mode of governing refers to a specific set of processes and techniques through which governing is pursued."[161] The main ways of governing climate change include self-governing, through which municipalities attempt to rule their own actions. Secondly, governing through provision includes developing resilient infrastructure systems as well as providing goods and services with a lower carbon footprint or improving adaptability.[162] The third mode of governance is via regulation – for instance, resorting to taxation and subsidies. Finally, enabling – the fourth method of regulation – involves approaches such as information and awareness campaigns, incentives and specific partnership patterns, in particular the involvement of economic actors – households, businesses, public authorities, civil society and so on. [163]

In conclusion, what can be drawn from this analysis is that the single notion of governance is no longer sufficient to grasp the complex environmental and climate governance framework. Indeed, the concept of governance has been adopted to refer to the wide range of governments, businesses and civil society organizations.[164] Cities are dynamic arenas, in continuous growth and evolution, which represent the core of modernization and urbanization processes. For these reasons, there is an increasing necessity to adopt new resilient initiatives and tools, other than a multi-layered, inclusive and sustainable approach to environmental governance.

1.3 Networking throughout resilient cities: from local to global environmental cooperation

At this point, it is now well established that cities are constantly challenged by increasing pressures, from climate change as the most urgent issue to widespread poverty and international

[159] Ivi, p. 549
[160] Bulkeley & Castán Broto, *op. cit*, p. 372
[161] Bulkeley, H., (2013) *Cities and Climate Changes*, London, Routledge, p. 92
[162] Ivi, pp. 92-93
[163] Ivi, pp. 93-94
[164] Ivi, p. 72

terrorism. The first responses to tackling climate change in cities began as a form of "municipal voluntarism", based on voluntary actions to address the threat. Individual municipalities – primarily in North America and Europe – have declared their intentions to reduce their carbon footprint through mitigation and adaptation initiatives. Indeed, since the early 1990s, cities have begun to prioritize projects and networks that enable them to connect and confront each other, share information on challenges and opportunities to face environmental change and strengthen cooperation. These transnational responses attempted to connect municipal authorities trying to respond to climate change.[165] In an era characterized by oppressive climatic threats, cities – after years of struggle – are at the forefront of this struggle, where sustainability and resilience are the conditions for survival, whereas there is no survival without cooperation.[166]

At the turn of the twentieth century, international networks were limited in number, only three of today's network. By 1960 this number had risen to 36 and by the end of the Cold War, it jumped to 107 from 56 in 1985. Environmental concerns and conferences throughout those years – the 1992 Earth Summit and Agenda 21 – were key factors of this expansion.[167] Therefore, it is not surprising that most international and urban networks are centered on environmental and climate matters. Nowadays, much of Los Angeles' emissions derive from the massive port activities and New York City's environmental footprint can be traced back to its buildings. These are only a small fraction of the huge impact and amount of GHG emissions produced by cities, and it is imperative that they act on the front lines, without hoping for intervention by states or municipal bureaucracies.[168]

Among the effective environmental networks, Local Governments for Sustainability (ICLEI) was founded in 1990 after the UN Conference on World Congress of Local Governments for a Sustainable Future, held in New York. During the conference, delegates were tasked with designing a new international environmental agency, the International Secretariat for Local Environmental Initiatives, with the aim of promoting and coordinating governments and global action to tackle climate change, the greenhouse effect, ozone depletion and environmental degradation in the third world. Furthermore, it would also ensure

[165] Ivi, pp. 74-75

[166] Barber, B. R., (2014) *If mayors ruled the world: Dysfunctional Nations, Rising Cities*. New Haven, Yale University Press, p. 130

[167] Acuto, M., & Leffel, B., (2021) Understanding the global ecosystem of city networks, *Urban Studies*, 58(9), p.1761. DOI: 10.1177/0042098020929261

[168] Ivi, pp. 130-131

cooperation between local and global governments and organizations.[169] Coming out of an UN-based conference, the ICLEI strongly pursues the U.N. agenda by focusing on the 1992 Rio Convention on Climate Change, Biological Diversity of the same year and on Desertification of 1994, along with the UN-Habitat and the Millennium Development Goals, later replaced by the United Nations Agenda 2030 for Sustainable Development.[170]

The organization includes more than 125 countries, 1200 municipalities and associations from 84 countries. Its focus is sustainable development and policy, emission reduction actions, nature-based and resilient solutions, a circular and green economy.[171] ICLEI conducts a multi-level work, building connections and alliances between local, national, regional and international actors, governments and cities worldwide.[172] In 1991, ICLEI originally launched the Urban CO_2 Reduction Project, bringing together American, Canadian and European cities and developed a municipal strategy framework to reduce the impact of GHG emissions. In the same year, the Cities for Climate Protection (CCP) campaign was established from the Urban CO_2 Reduction Project.[173] The CCP's program assumed that while greenhouse gas reduction efforts for each local government may be quite modest, through mutual collaboration cities can make a substantial contribution in the effort to mitigate climate change.[174] Therefore, its goal was to recruit as many cities as possible, whose collective emissions of greenhouse gases accounted for 10 percent of total emissions. In October 2002, the program reached 561 members worldwide, representing 8 percent of total GHG emissions.[175] Nowadays, within the ICLEI, the 100% RE Cities and Regions Network aims at accelerating the transition to renewable energy sources, through networking and cooperation opportunities between cities and regions that are part of the program. Participating actors include the city of Aspen (Colorado, U.S.), Malmö (Sweden), Tshwane (South Africa), Pingtung County (Chinese Taipei) and many others.[176]

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[169] World Congress for Local Governments for a Sustainable Future, (1990), *World Congress for Local Governments for a Sustainable Future; September 5-8, 1990, The United Nations, New York, USA*, p. 3 [online] Available at: https://escholarship.org/uc/item/5db0n36x

[170] Barber, B. J., *op. cit*., p. 134

[171] *Ivi*, p. 132; Iclei.org, (2019) ICLEI. [online] Available at: https://iclei.org/en/About_ICLEI_2.html.

[172] Iclei.org, ICLEI, [online] Available at: https://iclei.org/en/what_we_do.html

[173] ICLEI South Asia (n.d.) *Cities for Climate Protection (CCP) Campaign – ICLEI South Asia*. [online] Available at: https://southasia.iclei.org/cities-for-climate-protection-ccp-campaign/

[174] Betsill, M. M., & Bulkeley, H., (2004), Transnational Networks and Global Environmental Governance: The Cities for Climate Protection Program, *International Studies Quarterly*, Vol. 48, p. 477

[175] Ibid

[176] ICLEI – Local Governments for Sustainability, (2016) *Connect with the 100% Renewable Energy Cities and Regions Network*, Issue 1: September 2016, Bonn, Germany, p. 3

At the same level of as the ILCEI, the C40 Climate Leadership Group was born in 2005 in London and established – as it is today – as part of the Clinton Climate Initiative (CCI)[177], under the chairmanship of London's Mayor Ken Livingstone.[178] Initially, the C40 was characterized by representatives of only 18 megacities, known as the C20. However, by 2006, the C40 Steering Committee invited 22 other mayors to join, including other countries in the global South, thus becoming the C40. In the same year, Clinton's Climate Initiative became "our implementing partner on world-class climate action projects."[179] In 2010, New York City Mayor Michael R. Bloomberg was appointed chair of C40 and made a distinctive contribution in expanding the network's influence on the global climate fight. Through his philanthropic works, he witnessed the merger between the C40 and the CCI's Cities Programme forged by US President Clinton, bringing significant resources and contributions from prominent actors.[180] The C40 Leadership Group comprises 86 of the world's most influential human settlements, including Johannesburg, Honk Kong, Sidney, Tokyo, New Orleans, Copenhagen, with the aim of acting in line with the goals of the 2015 Paris Agreement and limiting global temperatures below 1.5 °C. In 2015, two-thirds of climate actions were carried out with other C40 cities and 95 percent planned expansion to a larger metropolitan scale. For instance, Changwon in South Korea applied cool roof techniques from tests in the C40 cities of Tokyo and New York.[181] The network formally elects the chair of the C40, a position currently held by London Mayor Sadiq Khan, who replaced Los Angeles Mayor Eric Garcetti in December 2021.[182] The C40 features a Steering Committee – representing the geographic diversity of members – and by a Board of Directors, whose presidency is covered by former C40's Chair and former New York Mayor Michael R. Bloomberg. [183]

The current climate crisis has been further exacerbated by the restrictions and losses resulting from the COVID-19 crisis, which represent a stress multiplier for city dwellers and now, more than ever, require global action in response. C40 Global Mayors' COVID-19 Recovery Task Force supports a post-COVID stimulus in support of a just and green recovery according to the

[177] The Clinton Climate Initiative was created in 2006 to tackle climate change and support communities as they adapt to its impacts. See more on: https://www.clintonfoundation.org/programs/climate-change-disaster-recovery/clinton-climate-initiative/
[178] Barber, B. J., *op. cit*., p. 134
[179] C40 Cities, (n.d.) *About C40*, [online] Available at: https://www.c40.org/about-c40/
[180] Ibid
[181] Acuto, M., (2016) Gives cities a seat at the top table, *Nature*. Vol 537, p. 612
[182] C40 Cities (n.d.) *The C40 Chair*. [online] Available at: https://www.c40.org/leadership/the-chair/
[183] C40 Cities, *About C40*, [online] Available at: https://www.c40.org/about-c40/

goals of the Paris Agreement. [184] The C40 Cities has established numerous networks and initiatives over its 15 years of activity. The Clean Air Declaration and Networks supports quality improvement for a healthier environment. In Quezon City in the Philippines, air pollution is mainly attributable to road transportation. However, the limited number of air monitoring stations limits the knowledge and intention of policy makers to intervene. However, thanks to detailed research and C40's Air Quality Technical Assistance, the expansion of roadside testing and air quality measurement has been improved. [185]

C40 input and networks on municipal waste management have helped cities generate intelligent responses especially during the COVID pandemic. For example, London developed a mechanism whereby contactless cup refills were reusable, with the aim of avoiding health problems and stimulating reusable items, an initiative that inspired the city of Vancouver to do the same. [186] Lastly, C40 Cities also supports the "15-minute city" a concept where city dwellers can access all their needs within a 15-minute walk or bike ride from home. This concept will stimulate healthier habits from walking and cycling, to avoid the use of private transportation, prompting the regeneration of neighborhoods. For instance, Barcelona's superblocks represent areas free of urban transport, increasing the walkability and cycling of urban neighborhoods, creative and inclusive green areas, essential in the aftermath of the COVID-19 pandemic.[187] The C40 represents one of the major international environmental networks, with its roots in the Clinton Climate Initiative. It now encompasses numerous networks, studies, initiatives, programs, promoting cooperation between global cities and multiple local areas, sharing ideas, knowledge and experience among them. The C40 Thriving Cities Initiatives, Women4Climate Initiative, City-Business Climate Alliance, Student Reinventing Cities[188] represent only a minimum part of the numerous initiatives in which the C40 Leadership Group is engaged, revealing the intricate relationships that this network has with municipalities, international organizations, actors and city businesses and young dwellers.

Among the environmental networks, the Climate Alliance was born in 1990 in Frankfurt. In this context, European network of local authorities committed to protecting the global climate. The member cities – nearly two thousand associated - aim to reduce greenhouse gas emissions and its impacts, working in collaboration with the indigenous populations of the rainforests in

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[184] C40 Cities, (2021) C40 *Annual Report 2020*, C40 Cities Climate Leadership Group, p. 6. Available at: https://www.c40.org/about-c40/

[185] Ivi, p. 8

[186] Ivi, p. 10

[187] Ibid

[188] C40 Cities, (2021) *op. cit.*, p. 14

the Amazon Basin.[189] The principles of the Climate Alliance are fairness, stressing that climate action must be fair; nature-based; local; resource-saving and diversity. These measures are at the very core of the Alliance's action to combat climate change.[190]

The World Mayors Council on Climate Change was established in 2005 in Bonn. It is a coalition of committed local government leaders interested on climatic issues. They encourage greater involvement of local governments as administrative stakeholders in multilateral efforts addressing climate change and related issues of global sustainability. [191] In the European context, membership in climate-change networks has grown rapidly over the past decade. *Energie-Cités,* founded in Besancon, France, in 1990, is a European association of local authorities involved in energy improvement through the initiatives and cooperation of European cities.[192] Most notable in the context of city networks is the United Cities and Local Governments (UCLG). The UCLG was created in 2004, when local and regional authorities decided to unite before the international community to provide an efficient response to the most imperative global challenges of the century, through cooperation, commitment and agreements.[193] Additionally, the Carbon Neutral Cities Alliance (CNCA) is a global city alliance with the purpose of achieving carbon-neutral cities by 2050 by reaching prosperity, social equality, climate resilience and better lifestyles.[194] CNCA mobilizes transformative and revolutionary climate action following seven strategic focus areas, most notably by funding climate policies, exerting collective influence on policy makers who can bring about actual changes (also, variety of stakeholders, private actors, academic and economic partners, experts in the field are involved), promoting governance methodologies and tools for zero-impact cities, promoting peer learning between frontline cities, cultivating innovative leadership, fluid communication between cities and favoring a fair future with zero emissions.[195] The CNCA includes cities such as Adelaide, Amsterdam, Boulder, Glasgow, Hamburg, Helsinki, London, New York City, Rio de Janeiro, Seattle, Sidney, Toronto, Vancouver and Yokohama, working together by exchanging their best experiences and practices.[196]

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[189] Barber, B. R., *op. cit*., p. 133
[190] Climate Alliance, *Climate Alliance – Principles.* [online] Available at: https://www.climatealliance.org/about-us/principles.html
[191] Barber, B. R., *op. cit*., p. 133
[192] Ibid
[193] UCLG, (n.d.) *Who we are*? [online] Available at: https://www.uclg.org/en/organisation/about
[194] Carbon Neutral Cities Alliance (n.d.) *About us.* [online] Available at: https://carbonneutralcities.org/about/
[195] Ibid
[196] Carbon Neutral Cities Alliance (n.d.) *Our cities*. [online] Available at: https://carbonneutralcities.org/cities/

Finally, the latest Global Covenant of Mayors for Climate & Energy (GCoM) is the largest global alliance for climate leadership, founded in 2016 and based on the involvement and commitment of over ten thousand cities and local governments. Originally, the Covenant of Mayors was launched in 2008, on the initiative of the European Commission. In 2014, the Compact of Mayors was created by UN Secretary-General Ban Ki-moon, UN Secretary-General's Special Envoy for Cities and Climate Change Michael R. Bloomberg and mayors from international city networks C40, ICLEI and UCLG.[197] European Commission Executive Vice President for the European Green Deal Frans Timmermans and UN Secretary-General's Special Envoy for Climate Ambition and Solutions Michael R. Bloomberg are now co-chairs of the GCoM board. [198]

The chapter began by pointing out that the first urban responses to global threats in the 1990s– *in primis*, climate change – were based on what Harriet Bulkeley (2013) defines municipal voluntarism, largely based on voluntary activities of municipal authorities and civil society as a means of addressing solutions to climate change, adaptation, and capacity building. However, at the turn of the century, more and more official, multilateral and global networks began to appear, strengthening the role of local communities and regions that had remained isolated for too long. As Acuto (2016) argues, the global importance of cities began to be widely recognized in the post-Paris era, after the development of crucial achievements in the struggle against climate change, i.e., the UN Sustainable Development Goals and the UN Sendai Framework for Disaster and Risk Reduction.[199] In conclusion, cities are not just connections and networks, but actual drivers of change and producers of a wide variety of policy outcomes.[200] By sharing knowledge and skills, directly involving city leaders, non-state and regional actors, they represent the very core of responses to climate change.

[197] European Commission, (2016) *EU Covenant and Compact of Mayors launch largest global coalition of cities committed to fighting climate change*, [online] Available at: https://ec.europa.eu/commission/presscorner/detail/it/IP_16_2247

[198] Global Covenant of Mayors, *Who we are*. [online] Available at: https://www.globalcovenantofmayors.org/who-we-are/

[199] Acuto, M., (2016) *op. cit.*, p. 611

[200] Acuto, M., & Leffel B., (2021) *op. cit.*, p. 1762

2. Urban climate actions: framing climate adaptation

> Parties hereby establish the global goal on adaptation of "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring adequate adaptation response in the context of the temperature goal referred to in Article 2".[201]

Article 7 of the Paris Agreement clearly states the centrality of adaptation measures in the fight against climate change, alongside the necessity to mitigate the primary causes of global climate change, expressed in Article 6 of the aforementioned. Article 4.1 (e) of the 1992 UNFCCC states that all Parties shall "Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans […]." Subsequently the 1997 Kyoto Protocol reaffirms the adaptation provisions already expressed in the UNFCCC, in Articles 10.1 (b), 10.1 (b) (i) and 10.1 (b) (ii), where the first expresses the implementation of national and regional mitigation measures and climate change adaptation plans. Despite the rife relevance given to mitigation actions by the international community, the UNFCCC, the Kyoto Protocol and the Paris Agreement contain significant provisions relating to adaptation measures. In recent years, the role of adaptation measures has experienced substantial growth.[202] The fifth Assessment Report by the IPCC defines adaptation as "The process of adjustment to actual or expected climate and its effects […]". In contrast to mitigation – which requires collective action adaptation is usually undertaken by individual entities. For example, states have an incentive to adapt because the benefits of adaptation measures generally flow into the implementing state. In this sense, the main role of international cooperation is to provide support for adaptation and facilitate the exchange of information.[203]

When addressing the concept of adaptation, three important aspects should be highlighted. First, countries that contribute less to climate change are those bearing the biggest burden. Therefore, in accordance with the restorative justice principle, the countries causing the problem should aid those who will bear a disproportionate share of the burden. Second, the countries most affected by climate change tend to be poor, with a very limited responsiveness, and the international community must help them build capacity. Finally, the adaptation challenges faced by different countries are similar, allowing states to learn from each other,

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[201] Paris Agreement, art. 7

[202] Franceschelli, F., (2019) *L'impatto dei cambiamenti climatici nel diritto internazionale*, Napoli, Editoriale Scientifica, pp. 309, 312

[203] Bodansky, D., et al., (2017) *International Climate Change Law*, Oxford, Oxford University Press, p. 14

sharing knowledge and information.[204] Therefore, adaptation measures pursue the objective of addressing these problems and finding solutions that allow adaptation to changing climatic conditions, while safeguarding human rights and the environment.[205] The main stages in the evolution of the notion of adaptation to climate change began after the Kyoto Protocol, and among its most important, the Adaptation Fund, set up in the context of the Marrakech COP-7 in 2001, proposed to help countries less developed to cope with the threats of climate change. Later, in 2007, the Bali Action Plan is rooted in the Bali's COP-13, establishing that adaptation measures represent one of the four milestones on which international environmental policy lies, along with emission reduction, technology transfer and financial support.

In 2009, Decision 1/CP.15, issued at the fifteenth 15th Conference of the Parties in Copenhagen, reaffirmed the central role of adaptation.[206] Furthermore, the role of adaptation also remained central in the context of the COP-16 held in Cancún in 2010 where the Cancún Adaptation Framework (CAF) underlines the equal weight of adaptation and mitigation actions.[207] Furthermore, the CAF proposed to stimulate research and evaluation cooperation on adaptation, strengthening collaboration and public awareness. During the conference, a process was introduced for least developed and other developing countries to develop and implement National Adaptation Plans (NAPs) to identify and address their adaptation needs in the medium and long term.[208] The COP Decision 1/CP.16 clearly invites all parties to "planning, prioritizing, and implementing adaptation actions, including projects and programmes, and actions identified in national and subnational adaptation plans and strategies […]."[209] Nowadays, countries are constantly producing NAPs and this number is expected to increase in the coming years. [210] For example, the Kiribati Islands in the Pacific focus on increasing water and food security through sector-specific approaches. In Guatemala, the RELIVE project aims to strengthen the resilience of the most vulnerable farmers and indigenous groups in the Mayan territory and in the Dry Corridor of Guatemala. [211]

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[204] Ibid
[205] Franceschelli, F., *op. cit.*, p. 310
[206] Ivi, p. 312
[207] *Ibid*
[208] UNFCCC, (n.d.) *Adaptation: Adapting to the impacts of climate change*, [online] Available at: https://unfccc.int/tools/cancun/adaptation/index.html
[209] UNFCCC, (2011) COP Decision 1/CP.16 Available from: https://unfccc.int/sites/default/files/resource/docs/2010/cop16/eng/09a01.pdf
[210] UNFCCC (2021) *National Adaptation Plans 2020. Progress in the formulation and implementation of NAPs*. UNFCCC, p. 5
[211] Ivi, pp. 6, 10

Subsequently, in 2015, in the context of the COP-21 in Paris, the Paris Agreement establishes – for the first time - a global objective for its parties in in the field of adaption, r which was then reaffirmed in the context of the Bonn COP-23, in 2017.[212] Article 7 (9) of the Agreement also states that "Each Party shall, as appropriate, engage in adaptation planning processes and the implementation of actions, including the development or enhancement of relevant plans, policies and/or contributions […]" A decision emerged during the Katowice COP-24 in 2018, the UNFCCC stimulated parties to strengthen adaptation planning and its implementation, taking into account the latest 2030 Agenda and the U.N. Sustainable Development Goals.[213] Another important aspect of the COP-24 was the adoption of the Paris Rulebook, a reference framework on the implementation of the points reached during the Paris negotiations. However, in this context, the adoption of the Paris Regulation was not completed due to several key issues that proved too difficult to reach an agreement. [214] Indeed, it was only at the 2021 COP-26 held in Glasgow that the negotiations on the Paris Agreement Rulebook were completed. During the formal talks, it was determined that the Rulebook would establish transparency and reporting requirements for all Parties in order to monitor progress on their emission reduction targets. [215]

The role of adaptation in the climate change regime has gained increasing importance in the last decades. The globe is experiencing severe changes in average temperatures and the occurrence of extreme weather events is intensifying. Indeed, the faster the climate changes and the longer adaptation efforts are postponed, the more difficult and costly it could be. For these reasons, countries, communities, and cities must develop adaptation solutions and implement actions to adequately respond to the impacts of climate change, as mitigation responses to climate change are not sufficient to reverse the severe effects of global warming in the short term. [216]

Adapting urban areas to climate change is not a new "standalone" task, but it requires changes in the way governments, businesses, and households behave and invest. It is widely

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[212] Franceschelli, F., *op. cit.*, p. 314

[213] Ibid

[214] Sky News. (n.d.) *COP26: What is the Paris Rulebook and will COP26 at last address carbon markets?* [online] Available at: https://news.sky.com/story/cop26-what-is-the-paris-rulebook-and-will-cop26-at-last-address-carbon-markets-12458205

[215] Mayors of Europe. (2021) *COP26: Paris Agreement rulebook has been completed*. [online] Available at: https://mayorsofeurope.eu/energetics/cop26-paris-agreement-rulebook-has-been-completed/

[216] UNFCCC, (2019) What do adaptation to climate change and climate resilience mean? [online] Available at: https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean

believed that discussions on climate change adaptation begin with assessing the degree of risk and vulnerability to climatic threats to which a specific region, country, or urban area is exposed. Only then it is considered what needs to be done and how.[217] To better comprehend the concept of adaptation it is necessary to make a distinction. The notion of adaptive capacity, also explained in the IPCC's AR5, refers to the ability of a system to take actions that help avoid major losses and accelerate recovery from the impacts of climate change. Whenever there is a lack of adaptive capacity, there follows the adaptation deficit, defined as the deficit in infrastructure, service provision and the institutional and governance system, which ensures adaptation actions.[218] In the context of urban climatic adaptation, what is needed is a more comprehensive risk assessment and a better understanding of how adaptation measures can serve and be integrated into development and disaster risk reduction. It is also important to acknowledge the willingness and ability of local governments to act. In many cities, risk assessments also include community-based assessments, such as that undertaken by the Philippines Homeless People's Federation, a national network engaged in a wide range of adaptation measures to address climate disasters, housing improvement and better economic opportunities.[219]

Indeed, it is essential to emphasize that whenever local municipalities are weak or ineffective, domestic and community strategies become vital to addressing and reducing the dangers and impacts of climate change in urban areas. For instance, individuals and businesses have taken both temporary and permanent measures to minimize the effects of climate change – floods, extreme heat, precipitation – by raising plinth levels, using flood-resistant building materials, and so on.[220] The city of Lagos, Nigeria, is characterized by its greatest vulnerability to sea-level rise, exposing the city and its dwellers to severe flooding, exacerbating/aggravating the conditions of poverty and uncertainty in which they live.[221] Poor urban planning leads to new development and housing in flood-prone areas or areas that should be left unexploited (e.g. wetlands). However, urban dwellers from different Nigerian communities have acted together to prevent environmental impacts and disasters, for example by building drains in front

[217] UN-Habitat, (2011) *op. cit.*, p. 129
[218] Ivi, p. 130
[219] Ivi, pp. 147, 135
[220] Ivi, pp. 131-132
[221] Adelekan, I.O. (2010) Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. *Environment and Urbanization*, 22(2), p.434

of homes; building high walls to prevent floodwater from entering and disrupting habitations; filling rooms with sand or sawdust; constructing trenches around houses and buildings.[222]

The case of Laos demonstrates a severe lack of government and local intervention, poor urban planning and a lack of cooperation between development and adaptation measures. On the contrary, effective collaboration between private parties, local communities and government actors is essential in order to effectively implement adaptation measures following precise evaluations and assessments. After an appropriate vulnerability assessment for the city, a more specific risk assessment should be conducted in specific sectors as climate change represents a significant danger in all sectors. For instance, in the context of infrastructure and settlements, appropriate adaptation options could be sea walls and storm surge barriers, the creation of marshlands or wetlands as a shield against sea-level rise and floods, as well as protection of existing natural barriers (reefs and mangroves).[223] Finally, urban authorities and planners should have a key role in developing strategic policies for the urban area and its surroundings, with the support of other stakeholders.[224]

2.1 Climate adaptation as a multidimensional approach: ecosystem-based solutions to restore nature in urban areas

As defined by the Convention on Biological Diversity, Ecosystem-based Adaptation (EbA) are nature-based approaches that employ biodiversity and ecosystem services to help people adapt to the adverse impacts of climate change.[225] Among the most effective EbA strategies is the restoration of coastal environments, starting with coral reefs, mangroves, dune systems and salt marshes/flats to cushion the force of tropical storms, floods and coastal erosions, reducing the risks to coastal communities. Subsequently, re-establish wetland and floodplain management to prevent flooding in urban areas and maintain stable water flow in the face of unstable rainfall events. Finally, EbA attempts strive to preserve and restore forests and other natural vegetation to secure/protect slopes, prevent landslides and regulate water flows.[226] A study conducted by the International Institute for Environment and Development (IIED), the International Union for Conservation of Nature (IUCN) and the United Nations Environment

[222] Ivi, pp. 434, 447
[223] UN-Habitat, (2011) *op. cit*., pp 147-148
[224] Ibid
[225] Swiderska, K., King-Okumu, C., and Islam Monirul, M., (2018) Ecosystem-*based adaptation: a handbook for EbA in mountain, dryland and coastal ecosystems*. IIED, London, p. 13
[226] Ivi, p. 14

Programme World Conservation Monitoring Centre (UNEP-WCMC) on thirteen EbA solutions in twelve countries has positively demonstrated that EbA actions support people and the ecosystems in adapting to climate change, sustain ecosystems in providing services for local populations, and are financially and economically viable.[227]

Indeed, through win-win outcomes, ecosystem-based adaptations protect particularly vulnerable communities from extreme climatic events while providing a range of benefits, crucial to human well-being and their protection from severe impacts. Furthermore, through the EbA an important contribution is made to the mitigation of climate change through the reduction of emissions deriving from habitat loss and environmental degradation. The United Nations Environment Programme is currently engaged in 45 ecosystem-based adaptation projects, particularly in least developed countries seeking to restore nearly 113,000 hectares of ecosystem lost due to the impacts of climate change.[228] The City Adapt project is using EbA endeavoring to build the resilience of urban systems in Latin American and the Caribbean. The rapid growth and urbanization of Latin America and the Caribbean region results in the exacerbation of socio-economic problems and the degradation of the urban system, aggravated by the severe impacts of climate change.

The project aims to address the vulnerability of three medium-sized cities, namely San Salvador (El Salvador), Kingston (Jamaica) and Xalapa (Mexico).[229] For instance, in all three cities a rainwater capture system (SCALL – *Sistemas de Captación de Agua de Lluvia*) allows rainwater storage to be used by urban dwellers and rural communities for daily purposes. The water is captured through a system of canals, passing through a purification and filtering system and then stored directly in tanks, ready for daily consumption. This system enables communities to use rainwater for agricultural production, animal husbandry, health care and so on. In fact, rainwater is collected on the roofs of buildings to which the inhabitants of the cities have access: houses, schools, churches, clinics.[230] In Jamaica, the rehabilitation of more than two hectares

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[227] Reid, H., et al., (2019) *Nature-based solutions to climate change adaptation*. IIED. Available at: https://pubs.iied.org/17725iied

[228] UNEP, (2021) *Ecosystem-based Adaptation*. [online] UN Environment Porgramme. Available at: https://www.unep.org/explore-topics/climate-action/what-we-do/climate-adaptation/ecosystem-based-adaptation?_ga=2.191590826.12798544772.1641373738-857605849.1637704904

[229] UNEP, (2019) *Ecosystem-based Adaptation in El Salvador, Jamaica and Mexico*. [online] UN Environment Porgramme. Available at: https://www.unep.org/explore-topics/climate-change/what-we-do/climate-adaptation/ecosystem-based-adaptation/ecosystem-6

[230] CityAdapt, (n.d.) *Sistemas de Captación de Agua de Lluvias (SCALL).* [online] Available at: https://cityadapt.com/sbn_cityadapt/scall/

of deteriorate wetlands and mangroves near Port Royal will improve water storage capacity, control soil erosion, and increase flood mitigation in the area.[231]

In Singapore, the Landscaping for Urban Spaces and High-Rises (LUSH) Programme seeks to encourage extensive and accessible greenery in the urban environment, to support urban rooftop agriculture and other sustainability-related functions, and to set Green Plot Ratio standards for private developments.[232] Shifting attention to the People's Republic of China, after decades of intense urbanization, over-exploitation and pollution, the country is now enduring water shortages and flood crisis, exacerbated by the climate emergency.[233] In this context, the Chinese government has introduced the idea of "sponge cities" to better address water and flooding crisis, monitor and improv the management of floods, water pollution and microclimates, recycle rainwater resources and restore degraded environments. They attempt to do this by incorporating a range of grey and green infrastructures, interrelated greenways and waterways, open green spaces, green roofs, permeable design interventions and drainage systems, water saving and recycling initiatives.[234] The government selected 30 cities as a pilot and verified the efficiency of sponge cities – Dalian, Chongqing, Shenzhen, Shanghai and many. more[235] The study of the case samples revealed several important lessons. These include a lack of green products and materials, climatic conditions – some city measures are not efficient at managing stormwater in cold, hot or arid climates – and a lack of local, provincial and national guidelines, designs and tools.[236]

Moving to the Middle East, with temperatures reaching peaks of 40°C and destined to increase and worsen in the upcoming future, the Thermal Modeling of Urban Trees project takes place in Abu Dhabi. It began with the collection of extensive data used in thermal model simulations to determine the most advantageous tree planning and green space configurations to reduce the urban heat island effect in residential areas of Abu Dhabi.[237] The results showed how in a low-rise Abu Dhabi neighborhood, planting Poinciana trees six meters apart in

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[231] CityAdapt (n.d.) *Restauración de Manglar*. [online] Available at: https://cityadapt.com/sbn_cityadapt/restauracion-de-manglar/

[232] Urban Redevelopment Authority, (n.d.) *Updates to the Landscaping for Urban Spaces and High-rises (LUSH) Programme: LUSH 3.0*. [online] Available at: https://www.ura.gov.sg/Corporate/Guidelines/Circulars/dc17-06

[233] Gill, D., (2021) *Sponge City Concepts Could Be The Answer To China's Impeding Water Crisis*. [online] Available at: https://earth.org/sponge-cities-could-be-the-answer-to-impending-water-crisis-in-china/

[234] Ibid

[235] Hui, L., (2017) Sponge City Construction in China: A Survey of the Challenges and Opportunities, *Water* 9(594), p. 3

[236] *Ivi*, pp. 7-8, 10

[237] PANORAMA, (2020). Thermal modeling of urban trees in Abu Dhabi. [online] Available at: https://panorama.solutions/en/solution/thermal-modeling-urban-trees-abu-dhabi

driveways and open spaces could reduce air temperatures by as low as 0.9°C, resulting in a significant reduction in energy consumption for air conditioning, (the largest energy requirement in the UAE), creating a cooler, healthier and more sociable environment for city dwellers.[238] The concept of ecosystem-based adaptation can be framed in the more general idea of nature-based solutions to tackle climate change, defined by the IUCN as "actions to protect, sustainably manage and restore natural or modified ecosystems, which effectively address societal challenges and adaptively, while providing benefits for human well-being and biodiversity."[239] In framing nature based-solutions (NbS), it is useful to think of it as an umbrella term that encompasses a whole range of ecosystem-based approaches to adapt to environmental changes.[240] This paragraph has tried to underline the central role of nature and ecosystem-based adaptation in the fight against climate change, underlining that the restoration and protection of nature is the primary strategy to combat global warming, and not just to mitigate and reduce the carbon footprint, but demonstrating the fact that the various array of ecosystems on our planet – forests, wetlands, oceans – are natural barriers against the extreme impacts of climate change "protecting homes, crops, water supplies and vital infrastructure."[241] Investments and attempts to promote and upgrade urban infrastructure to deal with the stresses of climate change and demographic trends require more holistic approaches that take into account nature, as EbA represents solid candidate solutions for regeneration and improvement of infrastructure.[242]

At the international and regional level, there are numerous actors, NGOs, city networks and initiatives involved in the development of sustainable and green adaptation solutions. Urban Innovative Actions is a European Union initiative that targets and supports European cities in adapting to climate change through innovative solutions. For instance, the IGNITION project is taking place in Greater Manchester, based on natural climate solutions to render the city green, resilient and low carbon. Greater Manchester is exposed to massive flooding due to the presence of rivers and canals; natural upland fires have started to be more common as summer

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[238] Ibid

[239] IUCN, (2016). Nature-based solutions. [online], IUCN. Available at: https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions

[240] Ibid

[241] UNEP, (2020). *Six ways nature can protect us from climate change*. [online] Available at: https://www.unep.org/news-and-stories/story/six-waysnature-can-protect-us-climate-chane

[242] Frantzeskaki, N., (2019) Seven lessons for planning nature-based solutions in cities. *Environmental Science and Policy*, vol. 93, p. 108

temperatures rise, exposing the city to more extreme climatic hazards.[243] The IGNITION project aims to address the lack of investment and involvement in nature-based solution strategies. Indeed, the project plans to establish new long-term financing, delivery, and maintenance mechanisms for NbS to achieve this target.[244] The project, through its investors, will provide a demonstration of the efficiency of green infrastructure in the form of a "Living Lab" at the Salford University campus.[245] Nowadays, the Living Lab represents the most visible result. It conveys continuous data and knowledge about the performance of different nature-based solutions. Other significant achievements are the spread of green spaces, such as the Sustainable Urban Drainage System (SuDS) in the streets of Salford and in West Gorton Manchester Park.[246]

In the U.S., New Orleans is situated in a low-elevation zone and is extremely susceptible to storm surges, extreme storm events and sea-level rise, making the city an easy target of climate change, the hardest hit in the U.S.[247] In 2005, the city suffered the acute impacts and consequences of Hurricane Katrina, which forced the largest and most abrupt displacement in US history with nearly 1.5 million people evacuated from the Gulf Coast region. As a result of Hurricane Katrina, New Orleans experienced land subsidence and accelerated sea-level rise, the dredging of approximatively 15,000 km of canals in the Mississippi River Delta area – primarily for oil and gas infrastructure–led to rife saltwater intrusion and ecosystem degradation.[248] In August 2015, the city released a comprehensive resilience strategy, the Resilient New Orleans, which fully addresses environmental, social, economic, and infrastructural challenges. Next, Climate Action for Resilient New Orleans: 50 percent by 2030 represents another major step in adapting and mitigating the impacts of climate change. [249] Major actions undertaken by the city of New Orleans include advancing coastal protection and restoration through the Coastal Master Plan which addresses land loss and erosion and improves storm buffers; invest in better water management systems with the Greater New Orleans Urban

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[243] UIA, (n.d.) *IGNITION – Innovative financinG aNd delivery of naTural climate sOlutioNs in Greater Manchester*, [online] Available at: https://uia-initiative.eu/en/uia-cities/greater-manchester

[244] Georgi, B., (2020) *The IGNITION project*, UIA, p.2

[245] Ivi, p. 5

[246] UIA, (2021) *First tangible results and a continuous learning loop – IGNITION Journal n3.* [online] Available at: https://uia-initiative.eu/en/news/first-tangible-results-and-continuos-learning-loop-ignition-journal-n3#4-conclusions

[247]Gotham, K. F., and Faust, M., (2020) Antagonisms of Adaptation: Climate Change Adaptation Measures in New Orleans and New York City. In: Laska, S., (ed) *Louisiana's Response to Extreme Weather: A Coastal State's Adaptation Challenges and Successes*, New Orleans, Springer Open, p. 99

[248] Ibid

[249] City of New Orleans, (2017) *Climate Action for a resilient New Orleans*, p. 8

Water Plan which offers a comprehensive approach to adapting urban areas across the region to live sustainably with water; investments in valuations and risk reductions.[250]

Adaptation to climate change has not always played a central role in the fight against global warming. However, in recent years, it has acquired a leading role at national and local level, being the fundamental tool that allows communities to live together and adjust to extreme climatic events. Indeed, the dynamism of climate change requires adaptation that can evolve with it. Climate change is no longer an external threat but has become an intimate element of human history and societies.[251] It is recognized that cities are extremely vulnerable to climate change, exposed to sea-level rise, flooding, extreme weather events, the heat-cup effect and many more. Therefore, raising awareness about the risks of climate change and the benefits of climate adaptation has gained prominence among local governments, families, communities, and businesses, learning that through cooperation and knowledge sharing it is possible to realize and implement plans for efficient adaptation. In conclusion, it is essential to understand that nature itself, our ecosystems, and environments, represent a solid shield against the impacts of climate change.[252]

2.2 Adaptation and resilience: two sides of the same coin

In addressing climate change and environmental policies, the notions of resilience and adaptation are often interchanged and referred to as the same concept. The IPCC defines adaptation as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid human or exploit beneficial opportunities. […]" and adaptive capacity as "the ability of a system, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences."[253] On the other hand, the IPCC characterizes resilience as "the capacity of social, economic and environmental systems to cope with a hazardous events or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and

[250] Ivi, p.15
[251] Pelling, M., (2011) *Adaptation to Climate Change. From resilience to transformation*. London, New York, Routledge, p. 14
[252] To learn more: https://www.unep.org/news-and-stories/story/six-ways-nature-can-protect-us-climate-change Six ways nature can protect us from climate change
[253] IPCC, (2014) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, Geneva, Switzerland, p. 128

transformation."[254] The definition provided by the IPCC is similar to Holing's definition of engineering resilience i.e., the ability of a system to return to its previous state of steady equilibrium. [255]

From a grammatical perspective, it can be deducted that *adaptation* is framed as a process of adjustment, a set of actions or sometimes the consequence of an action, whereas *resilience* is a condition or capacity to cope with shocks.[256] According to the Congressional Research Service of the United States, adaptation involves altering a system to integrate lasting or expected long-term climate-change while resilience is sometimes – but not always – considered as resistance to danger and reverting to pre-existing conditions, or "bouncing back."[257] Dhar and Khirfan (2017) discuss that bouncing back underline the system's ability to return to equilibrium or a steady state after a disturbance. Thus, this type of resilience enables the return to precedent state while dealing with disruption. [258] By ecological resilience, on the other hand, we mean the ability of a system to "absorb changes of state variables, driving variables, and parameters, and still persist" thus moving away from the ability of a system to return to its state of equilibrium and therefore adapt after disturbances have occurred. [259]

Resilience implies the ability to live in perilous, changing and precarious environments while maintaining the capacity to "absorb disturbances while retaining the same basic structure and ways of functioning" .[260] Perhaps building resilience should be conceived as a way to enable not only to cope with shocks and stress, but also to address the multiple obstacles that stand in the way of live and livelihoods.[261] As a result, many actions taken in urban areas by multiple actors contribute to building and strengthening resilience, for instance by improving infrastructure and services and, more importantly, by laying the foundations for climate adaptation processes. Therefore, a wide range of urban initiatives and projects can be

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[254] Ivi, p. 127

[255] Holling, C.S. (1996) Engineering Resilience versus Ecological Resilience. In: Schulze, P.E., (Ed.), *Engineering within Ecological Constraints*, Washington DC, National Academy Press p. 33

[256] CRS, (2021) *Climate Change: Defining Adaptation and Resilience, with Implications for Policy*, Congressional Research Service. [online] Available at: https://crsreports.congress.gov/product/pdf/IF/IF11827

[257] Ibid

[258] Dhar, T.K., & Khirfan L., (2017) A multi-scale and multi-dimensional framework for enhancing the resilience of urban form to climate change. *Urban Climate*, vol. 19, p.74

[259] Holling, C.S., (1973) *op. cit*., p. 17

[260] Parry, M., et al., (2007) *Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge, Cambridge University Press, p. 880

[261] UN-Habitat, (2011) *op. cit*., p. 149

understood as contributing to the reduction of the adaptation deficit, i.e., the inability to cope with climatic conditions, and to the increase of urban resilience to climate change.[262]

British Geographer Hariett Bulkeley in *Cities and Climate Change* (2013) argues that resilience can be considered as one possible form of adaptation response, drawing on Mark Pelling's *Adaptation to climate change: From resilience to transformation* (2011), suggesting that resilience can be conceived as one form of adaptation that "seeks to secure the continuation of desired systems functions into the future in the face of changing context, through enabling alteration in institutions and organizational forms."[263] Pelling identifies two additional forms of adaptation, namely transitional adaptation and transformational adaptation, considering the three levels of adaptation as "nested and compounding", so that changes at one level can create opportunities for another. Pelling's layered report on adaptation is valuable as it allows us to think about the different ways in which adaptation could be pursued and how this is organized by different social, economic and political objectives. [264]

Another interesting perspective on the relationship between adaptation and resilience is given by Dhar and Khirfan (2017). To be more precise, the comparison is made between adaptive capacity and resilience, where adaptive capacity "refers to a system's ability to adapt to the impacts of climate change […]". [265] Indeed, improving the adaptive capacity of a system can reduce its exposure to environmental change, thereby reducing the vulnerability of the system and increasing its capacity to cope with uncertainty, i.e., the resilience of the system.[266] Beatley (2014) asserts that adaptive capacity is often deemed as a key feature of resilience, the idea that it is not practicable or even desirable to return to a previous condition and that entities (people, organizations and communities) should attempt to learn from and respond creatively to disruptive events, moving from a shock or disaster to a new and perhaps enhanced set of conditions. [267]

Today more than ever, cities represent the fulcrum of development and urbanization processes, providing their dwellers with great opportunities and connections. However, urban centers can also exacerbate some of the world's most serious environmental and socio-

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[262] *Ivi*, pp. 149-150
[263] Pelling, M., o*p. cit.*, p. 55
[264] Bulkeley, H., (2013) *op. cit*., p. 148
[265] Dhar, T.K., & Khirfan L., *op. cit.*, p. 76
[266] Ibid
[267] Beatley, T., (2015) Planning for Resilient Coastal Communities: Emerging Practice and Future Directions. In: Glavovic, B.C. and Smith, G.P., (eds.) *Adapting to Climate Change: Lessons from Natural Hazards Planning*. Dordrecht, Netherlands, Springe, p. 127

economic challenges. Cities concentrate millions of people in sites that can be extremely vulnerable to numerous types of disasters, poverty, and the impacts of climate change.[268] The Resilient Cities network defines urban resilience as the ability of a city's systems - businesses, institutions, communities and individuals - to survive and *adapt*, in the face of chronic stress and shock, despite their magnitude and impact. Indeed, the overview of a resilient urban future requires addressing challenges and creating solutions in a placed-based, integrated, inclusive, risk-aware, and forward-looking manner.[269] The ICLEI deems a resilient city capable of absorbing and recovering from any shock or stress while maintaining its essential functions, structures, and identities as well as *adapting* and thriving in the face of constant change. Building resilience implies identifying and assessing risks, reducing vulnerability and exposure, and ultimately, increasing resistance, adaptive capacity, and emergency preparedness.[270]

In conclusion, it can be said that resilience and adaptation represent two vital aspects of the fight against climate change, interrelated in addressing environmental risks, preparing cities to face the many challenges that the future poses to them. Urban adaptation to climate change is an essential trait of resilience, which in turn involves adaptation to urban climate among its many characteristics.

3. The United Nations regime on urban development and sustainable cities

In the context of the 1992 Earth Summit held in Rio de Janeiro, numerous environmental landmarks were achieved in the negotiation processes, starting from the Rio Declaration on Environment and Development, the Framework Convention on Climate Change, the Convention on Biological Diversity, the Statement on Forest Principles, and the Agenda 21. The Agenda 21 aimed at preparing the world for the challenges of the 21st century. It is articulated in four sections divided by macro-arguments with forty chapters offering an action plan for sustainable development, combining the environmental with social and economic matters and conveying a participatory, community-based approach on a wide range of issues.[271]

The preamble declares that "It reflects a global consensus and political commitment at the highest level on development and environment cooperation. Its successful implementation is first and foremost the responsibility of Governments. National strategies, plans, policies and

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[268] UNEP, (2021) S*mart, Sustainable and Resilient cities: the Power of Nature-based Solutions*, p. 6

[269] Resilient Cities Network (n.d.) *What is urban resilience?* [online] Available at: https://resilientcitiesnetwork.org/what.is.resilience/

[270] ICLEI, (2019) *Resilient cities, thriving cities: The evolution of urban resilience*. Bonn, Germany, p. 5

[271] Blewitt, J., *op. cit.*, p. 13

processes are crucial in achieving this. International cooperation should support and supplement such national efforts."[272] Chapter 7 promotes sustainable human settlement development and in article 7.4 it is stated that "the overall human settlement objective is to improve the social, economic and environmental quality of human settlements and the living and working environments of all people, in particular the urban and rural poor."[273]

Chapter 28 of the Agenda 21 specifically concerns sustainable development in local areas. In fact, the expression "Local Agenda 21" (LA21) refers to the general goal set by Chapter 28 for local communities.[274] This chapter represents a plea for a new era of dialogue and a combined strategy to achieve sustainable development at the local level. This section provides few suggestions on how local communities should advance with a Local Agenda 21 process. Each community must find the most suitable path based on its geographic, demographic, economic, societal, and cultural characteristics. In Western Europe, the most significant initiatives and organizations developing sustainable initiatives in local areas are the International Council on Local Environmental Initiatives (ICLEI), the European "Sustainable Cities and Towns Campaign", and the "Aalborg Charter".[275] The Aalborg Charter 1994 is an urban sustainability initiative approved in the context of the first European Conference on Sustainable Cities & Towns in Aalborg, Denmark. It was inspired by the Rio Earth Summit Local Agenda 21 project, with the aim of supporting the European Union's Environmental Action Programme, "Towards Sustainability".[276] Despite being a non-binding instrument, the LA21 achieved great popularity in the early 21st century, as many countries had policies and frameworks for sustainable development at local and regional level, with municipalities taking the lead. In Scandinavian countries, where local governments retain considerable autonomy in environmental matters, LA21 has been most successful.[277] In the framework of the Earth Summit many important and enduring accomplishments have been achieved, one of which is represented by the LA21. Within the Local Agenda 21, the results of sustainable development

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[272] United Nations Conference on Environment & Development (1992) *Agenda 21*. Available at: https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

[273] Ibid

[274] Coenen, F., (2008) Local Agenda 21: 'Meaningful and Effective' Participation? In: Coenen, F., (ed.) *Public Participation and Better Environmental Decisions, the promise and limits of participatory process for the quality of environmentally related decision-making*. Dordrecht, Netherlands, Springer, p. 165

[275] Ivi, p. 167

[276] Sustainable City Platform, (n.d.) *The Aalborg Charter*. [online] Available at: https://sustainablecities.eu/the-aalborg-charter/

[277] Blewitt, J., (2018) *op. cit*., p. 13

must be obtained through a broad process involving local authorities, citizens, and relevant stakeholder groups; and possibly be integrated with existing plans, priorities and agendas. [278]

In September 2015, after more than two years of confrontation and engagement with numerous stakeholders, the UN General Assembly adopted resolution 70/1, "Transforming our world: the 2030 Agenda for Sustainable Development." The document represents a remarkable decision on a comprehensive, broad and people-centered set of universal and transformative Goals and objectives.[279] The Agenda 2030 is accepted by all countries and is applicable to all, considering the different national realities, capabilities and levels of development, respecting national affairs and priorities. The new Agenda contains 17 Sustainable Development Goals (SDGs), with 169 targets associated with the pursuit of achieving global development and "win-win" cooperation, bringing vast benefits to all countries[280]. The present framework represents a follow-up of the United Nations Millennium Declaration (A/RES/55/2), established by the UN General Assembly in September 2000. However, in terms of scope, the Agenda 2030 goes beyond the Millennium Development Goals – established within the Millennium Declaration.[281]

Regarding sustainable development in urban areas and cities, the Agenda 2030 recognizes that sustainable urban development and management are vital for the quality of life of people and communities. In subparagraph 34 it is stated that "We will reduce the negative impacts of urban activities and of chemicals which are hazardous for human health and the environment, including through the environmentally sound management and safe use of chemicals, the reduction and recycling of waste and the more efficient use of water and energy. And we will work to minimize the impact of cities on the global climate system […]." In the framework of the SDGs, Goal 11 (SDG 11) proposes to "make cities and human settlements inclusive, safe, resilient and sustainable." There is increasing recognition of the horizontal nature of urban issues, which have a direct impact and connection with several other SDGs, including SDG 1, "end poverty and its form everywhere", SDG 6 "ensure availability and sustainable management of water and sanitation for all", SDG 7 "ensure access to affordable, reliable, sustainable and modern energy for all", SDG 8 "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all", and SDG 12

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[278] Coenen, F., *op. cit.*, p. 167

[279] United Nations General Assembly Resolution No 70/1*: Transforming our world: the 2030 Agenda for Sustainable Development* (25 September 2015). A/RES/70/1 [online]. Available at: https://sdgs.un.org/2030agenda

[280] Ibid

[281] Ibid

"ensure sustainable consumption and production patterns."[282] More specifically, the Declaration asserts that the main goals are to improve by 2030 "inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries", reducing "the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management" and providing "universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities."[283]

Furthermore, SDG 11 also promotes equal access to safe housing and basic services, whereas the former Millennium Development Goal 7, target 11, required only efforts to accomplish "a significant improvement in the lives of at least 100 million slum dwellers" by 2020.[284] Article 11.b states the objective of increasing "the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels."[285] For the first time, SDG 11 ascertains a global position of urban policy in a unified statement concerning the overall social, economic, and environmental functioning of cities and the urban system.[286]

Numerous actions have been launched following the principles of the Agenda 2030. For instance, following SDG 11, Hanoi, Vietnam, launched its first 14.7 km bus line in 2017, serving approximatively 14,000 people daily. According to the Hanoi Urban Transport Development Project, an estimated 23 percent of those bus riders switched to urban transportation from driving private vehicles, reducing the city's carbon emissions by 122,177 tons by 2025.[287] "Reinventing Cities" is a competition organized by C40, with the help of the European Institute of Innovation and Technology Climate Knowledge and Innovation Community (KIC). The main goal is to deliver and stimulate urban projects to provide zero-emission and resilient urban restoration in declining sites.[288]

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[282] United Nations, (2015) *Sustainable cities and human settlements* [online] Available at: https://sustainabledevelopment.un.org/topics/sustainablecities

[283] United Nation General Assembly, (2015) *op. cit.*, Subparagraphs 11.3, 11.6 and 11.7

[284] United Nations, (2015) *Sustainable cities and human settlements*

[285] United Nation General Assembly, (2015) *op. cit.*, p. 22

[286] Parnell, S., (2016) Defining a Global Urban Development Agenda, *World Development*, vol. 78, p. 530

[287] Knudsen, C., et al., (2020), *World Cities Report 2020: The Value of Sustainable Urbanization*, UN-Habitat, p. 116

[288] Ivi, p. 117. To learn more: https://www.c40reinventingcities.org

Further examples can be given by the SDG Acceleration Actions, a series of voluntary activities undertaken by private actors, non-state actors, NGOs and many others for the achievement of the 17 SDGs. The City Water Resilience Approach (CWRA) is a stakeholder-led [289] approach enabling a holistic view of water systems and building resilience in urban areas. It promotes engineering infrastructures as well as nature-based solutions and a series of "soft" plans – improvements to governance, communication, and management.[290] The present approach has been applied to variety of waterside cities – Cape Town, Miami, Stockholm - stimulating urban water resilience. The present Project aims at helping the implementation of SDG 6 (clean water and sanitation), 11 (sustainable cities) and 13 (climate action), ensuring basic services, addressing water scarcity and management, and improving capacity on adaptation.[291]

In addition, the Sendai Framework for Disaster Risk Reduction and the Addis Ababa Action Agenda for Financing for Development are worth mentioning. The former was conceived by the UN General Assembly in the context of the Third UN World Conference on Disaster Risk Reduction (WCDRR) to collaborate with the 2015 Paris Agreement, the Addis Ababa Action Agenda (AAAA) on Financing for Development, the NUA and the SDGs.[292] Its main objectives include the aim of investing in disaster risk reduction for resilience by promoting "mechanisms for disaster risk transfer and insurance, risk-sharing […] in order to reduce the financial impact of disasters on Governments and societies, in urban and rural areas."[293] The latter represents the outcome of the gathering in Addis Ababa, Ethiopia, in July 2015 with the purpose of addressing the challenges of financing and creating a favorable environment at all levels for sustainable development, following the principles of global partnership and solidarity.[294]

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[289] The main stakeholders of the CWRA are the British firm Arup, the Stockholm International Water Institute (SIWI) and Resilient Cities Network (RCN), the World Bank and the Rockefeller Foundation. To learn more: https://sdgs.un.org/partnerships/city-water-resilience-approach-cwra-1

[290] United Nations, (n.d.) *City Water Resilience Approach* (CWRA) [online] Available at: https://sdgs.un.org/partnerships/city-water-resilience-approach-cwra-1

[291] Ibid

[292] UNDRR, (n.d.) *What is the Sendai Framework?* [online] Available at: https://www.undrr.org/implementing-sendai-framework/what-sendai-framework

[293] United Nations General Assembly Resolution No 69/283: *Sendai Framework for Disaster Risk Reduction 2015-2030 (3 June 2015)* [online] A/RES/69/283 Available at: https://www.preventionweb.net/files/resolutions/N1516716.pdf

[294] United Nations General Assembly Resolution No *69/313: Addis Ababa Action Agenda of the Third International Conference on Financing for Development (Addis Ababa Action Agenda)* (27 July 2015) [online] A/RES/69/313.

Subsequently, in October 2016, the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) was held in Quito, Ecuador. The United Nations General Assembly drafted Resolution 66/207 to ratify the New Urban Agenda (NUA), deciding to convene the Habitat III Conference to strengthen the global commitment to sustainable urbanization.[295] The NUA defines a strong benchmark for the kind of development it should be striving for, and a global accountability framework to achieve it.[296] The broad purpose of the NUA is to address how cities are designed, planned, developed and governed to end extreme poverty, guarantee gender equality, promote inclusive and sustainable economic growth, endorse sustainable development, improve human health and well-being, foster resilience and environmental protection.[297] Considering the important environmental landmarks accomplished throughout 2015, the NUA reaffirms the comprehensive commitment to sustainable urban development, contributing to the realization of the Agenda 2030 for Sustainable Development and Goal 11 of making cities and human settlements inclusive, safe, resilient and sustainable.[298] Consequently, principle 14 (c) states that the NUA will ensure "environmental sustainability by promoting clean energy and sustainable use of land and resources in urban development, by protecting ecosystems and biodiversity, including adopting healthy lifestyles in harmony with nature, by promoting sustainable consumption and production patterns, by building urban resilience, by reducing disaster risks and by mitigating and adapting to climate change."

With 175 paragraphs and an inter-governmental policy agenda, it is believed that the implementation of the NUA will be complicated. NUA's delivery necessitates professionals to elaborate efficient strategies, policies, projects and tools to help with some of the core challenges of the 21st century.[299] For this reason, the UN-Habitat recommended the Action Framework for Implementation of the New Urban Agenda (AFINUA). This framework was conceived as a basis for achieving the urban dimensions of the SDGs, as well as further global development frameworks relevant to sustainable urbanization – the Paris Agreement on Climate Change, the Sendai Framework for Disaster Risk Reduction, and the Addis Ababa Action Agenda. The AFINUA sets out the following central themes: national urban policies; urban

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[295] UN-Habitat, (n.d.) *Habitat III* [online] Available at: https://unhabitat.org/habitat-iii

[296] Hartley, L., (2017) The New Urban Agenda: ten things you need to know, *Landscape Architecture Australia*. No. 153, p. 18

[297] United Nations General Assembly Resolution No 71/254*: New Urban Agenda*. (23 December 2016). A/RES/71/256.

[298] Ibid

[299] Hartley, L., *op. cit*., p. 18

legislation, rules and regulations; integrated urban design and territorial planning; urban economy and municipal finance and local implementation.[300] Of course, in an ideal situation, these elements should be interconnected and mutually reinforcing. However, such a relationship could not occur automatically, but should be facilitated and enhanced by effective policies, planning and institutions.[301] In this sense, according to Hartley (2017), collaborations and partnerships are required at all levels of government but above all by professionals, communities, the private sector and civil society, "through formal and informal peer-to-peer learning networks". This cooperation process will be increasingly challenging in the coming years.[302]

Finally, it can be asserted that cities are not mere places of development, but represent the centrality of urban hubs, where important development processes take place, cultural, human and economic networks are interrelated and where the implementation of all the SDGs is now more possible than ever. It is widely believed that the central problem of the Habitat III agenda, assuming that the future of the city is fundamental for the achievement of global sustainable development, is that of defining adequate actions after 2015 that will lead the world into the urban Anthropocene.[303]

3.1 Glasgow for powerful cities: the contribution of the last Conference of the Parties to the urban agenda

The previous paragraph was intended to show the most prominent measures and actions in the field of urban development and improvement. It is evident that in the last decade there has been a great deal of attention to cities as leading hubs for sustainable development, in particular from the implementation of the Agenda 2030 for Sustainable Development and the 17 SDGs. This focus on urban areas was also seen during the 2021COP26 held in Glasgow, Scotland, last November. On 11 November, the centrality was on Cities, Regions and Built Environment, and representatives from cities and regions from around the globe gathered to discuss what urban solutions could lead to environmental problems. In this context, the role of Local Governments and Municipal Authorities (LGMA) - representing cities and regions since the first COP - was invaluable in the negotiation process that ultimately led to the Glasgow Climate Pact, with the

[300] Knudsen, C., et al., *op. cit.*, p. 9
[301] Ibid
[302] Hartley, L., *op. cit.*, p. 20
[303] Parnell, S., *op. cit.*, pp. 538-539

intention of maintaining the 1.5°C objective alive by raising NDCs' ambition and to the Glasgow work programme for Action for Climate empowerment. The LGMA has particularly urged recognition of the importance of local, national and regional planning in enhancing transparent collaboration on environmental matters. [304]

On the same day, the £27.5 million Urban Climate Action Programme was launched to provide technical assistance to at least 15 mayors of mega-cities in developing countries, supporting them in setting and realizing goals to achieve net zero emissions creating resilience to climate change. [305] The Cities race to zero is a campaign for cities, organized by the C40 Cities, the ICLEI, the GCoM, the World Wide Fund for Nature (WWF) and the World Resources Institute (WRI). Its aim was to recruit 1000 cities by COP26.[306] As Day 11 dawned, 1,049 cities and local governments participated in the Race to Zero. Among these, 593 cities committed to adopting and switching to sustainable energy systems, 501 were working to develop zero-impact buildings and 415 aimed at reducing waste production.[307] Under the leadership of Scotland, Lombardy and Regions4, 16 regional governments and networks have appealed to national governments to stimulate emission reductions, assessable and coherent actions and solution-oriented collaborations.[308] As part of the LGMA Multi-Level Action Pavilion programme, the event "The Leading role of regions in raising ambition for adaptation and resilience" involved 12 regional governments and 20 organizations to promote a multi-layered partnership with the UNFCCC Parties to accelerate efforts on climate actions. [309]

Furthermore, under the C40 Clean Construction Declaration, San Francisco has joined Los Angeles, Mexico City, Oslo and Budapest in committing to at least halve the emissions from the initial construction of buildings by 2030, with a 30 percent reduction by 2025. In addition, Beijing and Qingdao, China, have joined the C40'S Clean Construction Programme, officially partnering with peer cities to strengthen the transition to resource-efficient construction and infrastructure. [310]

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[304] LGMA (n.d.) *Advocacy Outcomes: Cities and regions in the climate negotiation process*. [online] Available at: https://www.cities-and-regions.org/outcomes/#1637141528620-ef2d172e-9f75

[305] Topping, N., (2021) *Top of the COP: Cities, Regions, & the Built Environment* [online] Available at: https://www.linkedin.com/pulse/top-cop-cities-regions-built-environment-nigel-topping/

[306] Global Covenant of Mayors for Climate & Energy. (n.d.) *Cities Race To Zero*. [online] Available at: https://www.gcom-oceania.org/race-to-zero-1

[307] Topping, N., *op. cit.*

[308] Ibid

[309] Regions4. (2021) *Regional governments call for multi-level governance & radical collaboration to deliver for climate*. [online] Available at: https://www.regions4.org/news/regional-governments-cop26-call-to-action/

[310] Topping, N., *op. cit.*

> "Of almost 30 years of COP meetings, COP26 is the first one in which local and city governments came with a voice and led by example. It is the first time that we were able to show the pledge of 1,049 cities who already have climate action and investments,"[311]

The statement by Claudia López, Mayor of Bogota, Colombia, and co-chair of the C40 Cities Group, underlines that the role of cities and their governments in negotiations on climate change and in addressing the perils of environmental changes are nowadays stronger and necessary. She added, in the context of the COP26 in Glasgow, that cities and municipalities were finally converging together to demonstrate commitment, to demand national governments and private corporations to serve their part and to "align their incentives and their investments with climate action plans with our citizens' demand for *actual* change."[312] Huston Mayor, Sylvester Turner, emphasizes the leading roles of mayors when it comes to delivering concrete results on the climate agenda, defining them "boots on the ground, the boats on the water." Inger Anderson, head of the United Nations Environment Programme, actively participated in the COP26 panel, calling for more energy efficient buildings, pointing out that a typical construction built today will still be in use by 2070 and therefore, greater emphasis should be placed on resilience.[313]

In conclusion, it is well established that the role of urban areas and cities in the fight against climate change has resisted consistent growth and involvement over the last decade, supported by numerous urban initiatives. COP26 showed an unprecedented level of involvement from cities, mayors, regional governments, city networks, NGOs, and private actors, ready to get involved in transforming cities into smart, resilient, and sustainable hubs, thus ready to accelerate the transition to zero-emissions centers, strengthening international, regional and local cooperation. More importantly, each of us can bring significant transformations in tackling climate change. "All are important. All make a difference. But none is enough."[314]

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[311] United Nations, (2021) COP26: *Promises "ring hollow" when fossil fuels still receive trillions in subsidies; UN chief calls on negotiators to pick up the pace*. [online] Available at: https://news.un.org/en/story/2021/11/1105562?utm_source=UN+News+-+Newsletter&utm_campaign=dc915016a1-EMAIL_CAMPAIGN_2021_11_11_06_05&utm_medium=email&utm_term=0_fdbf1af606-dc915016a1-107868485

[312] Ibid

[313] Ibid

[314] Bloomberg, M., and Pope, C., (2017) *Climate of hope: how cities, businesses, and citizens can save the planet.* New York, St. Martin's Press, p. 261

CHAPTER 3. URBAN SUSTAINABLE SOLUTIONS THROUGHOUT EUROPEAN CITIES: POLICY AND LEGISLATION IN THE EUROPEAN UNION

1. The main stages of the European Union legislation on environmental matters

The original Treaty of Rome or Treaty establishing the European Economic Community 1957 did not address environmental matters, considering that at the time no explicit environmental problems were threatening the six Member States and because the European Community was primarily interested in and involved with policies aiming at the creation of a European Common Market.[315] In 1987, Title VII of the Single European Act (SEA) included a section dedicated to the environment regulated by articles 130r, 130s and 130t in which were explaining the actions that the Community needed to adopt to "preserve, protect and improve the environment" to protect human health and to promote a wise and rational usage of natural resources.[316] Moreover, in Article 130r (2) were established one of the most imperative principles of international environmental law, namely, the principle of preventive action and the polluter-pays principle.[317] With the 1992 Treaty of Maastricht or Treaty on the European Union (TUE), the Environment becomes more embedded within the Community's policy framework. Indeed, with the Treaty of Maastricht, the EEC lose its "economic" designation, evolving into European Community (EC), making room for a more widespread set of policies.[318] Moreover, in the context of the Treaty of Maastricht, the precautionary principle was included with regard to environmental matters.[319]

In 1993, the Fifth Environmental Action Programme adopted a horizontal and more inclusive approach on the environment, seeking to facilitate a more direct intervention from all the actors involved, including the straightforward participation of companies, NGOs and the civil society. Later, Decision no 2179/98/CE of the European Parliament and the Council promote the integration of environmental policies into the Community's policies. [320] In 1999, the Treaty of Amsterdam reaffirms the centrality, at the Community level, the principle of sustainable

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[315] Lugaresi, N., (2020) *Diritto dell'ambiente*, 6ª Edizione, Milano: Wolters Kluwer, p. 51

[316] *Single European Act* (26 June 1987), 169/4. Official Journal No L 169/4 Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:11986U/TXT

[317] Ibid

[318] Lugaresi, N., *op. cit.* p. 52

[319] Franceschelli, F., *op. cit.*, p. 90

[320] Lugaresi, N., *op. cit.* p. 52

development stressing the importance and the need to integrate environmental policies with other Community's policies.[321] A further important step in delineating environmental matters occurred with the Charter of Fundamental Rights of the European Union drafted and proclaimed in Nice on December 2000. Article 37, under Chapter VII, "Solidarity", express that "A high level of environmental protection and the improvement of the quality of the environment must be integrated into the policies of the Union and ensured in accordance with the principle of sustainable development."[322] This provision specifically aimed at protecting the environment, which should be of inspiration to European policies in all policy areas.[323] In the same year, The European Commission established the European Climate Change Programme (ECCP) in order to identify the most environmentally and cost-efficient actions and policies to cut greenhouse gas emissions at the European level, with the primary goal of ensuring that the EU met its target for reducing emissions pursuant the Kyoto Protocol. [324]

Nowadays, the Treaty of Lisbon amended the Treaty on the European Union and the Treaty establishing the European Economic Community, establishing the Treaty of Lisbon and the new Treaty on the Functioning of the European Union (TFEU) as the legal foundation of the European Union. Indeed, the TFEU establishing shared competence between the Union and the Member States on a variety of areas, including the environment. [325] Environmental affairs are now regulated by article 11 TFEU – ex Article 6 TEC - ascertaining that "Environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities, in particular with a view in promoting sustainable development."[326] The present article stipulates the integration principle, extending the necessity of applying environmental protection even when the European Union adopted policies of different nature.[327] More specifically, the section dedicated to the environment is Part III, Title XX, articles 191-193 (ex-articles 174-176). Article 191 (1) establishes the environmental objectives that the Union shall pursue, including preserving and improving the quality of the environment, safeguarding human health, and the adoption of measures to combat climate

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[321] Ivi, p. 53

[322] *Charter of Fundamental Rights of the European Union* 2000/C 364/1 (18 December 2000) [online]. Available at: https://www.europarl.europa.eu/charter/pdf/text_en.pdf

[323] Franceschelli, F., *op. cit*. p. 91

[324] European Commission, (n.d.) *European Climate Change Programme* [online] Available at: https://ec.europa.eu/clima/eu-action/european-climate-change-programme_it

[325] *Consolidated version of the Treaty on the Functioning of the European Union* (26 October 2012) Official Journal No 326/47.

[326] Ibid

[327] Franceschelli, F., *op. cit*. p. 93

change.[328] Paragraph two continues recalling the four environmental law principles through which the Union shall act, namely the precautionary principle, the preventive principle, the principle that environmental damage should as a priority be rectified at source and the polluter-pays principle.[329] Article 92 establishes the legal basis for the European Union intervention in environmental subjects. With regard to urban planning, art. 192 (2) (b) determines that "[…] the Council acting unanimously in accordance with a special legislative procedure and after consulting the European Parliament, the Economic and Social Committee and the Committee of the Regions" shall endorse measures affecting city and country planning. [330] Finally, Article 193 allows Member States to introduce more rigorous protective measures whenever the ones adopted by the EU are not deemed as such by State Members.[331]

At the European level, it is a well-established the truth that climate change represents a real and severe threat, and it is mainly human-driven, recognizing that the reduction of GHG, such as carbon dioxide, methane and nitrous oxide are imperative to avoid climate change. [332] Indeed, climate change will inevitably lead to significant economic and social impacts – other than environmental ones – with some regions, sectors and category of people, likely to bear the greatest burden. Therefore, addressing climate change requires the reduction of greenhouse gas emissions through mitigation efforts and taking adaptation actions to deal with more short-termed unavoidable impacts.[333] The 2009 White Paper on European climate adaptation laid out several measures that have been implemented successfully. A key tool was the web-based European Climate Adaptation Platform (Climate-ADAPT), launched in March 2012, incorporating the latest data on adaptation actions in the EU, together with valuable policy support tools. The EU has started to integrate adaptation into several of its own policies and financial programs.[334] Climate change effects vary across the EU depending on climate, geographic and socioeconomic conditions. The Mediterranean basin are increasingly exposed

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[328] *Consolidated version of the Treaty on the Functioning of the European Union*, Art. 191 (1)

[329] Ivi, Art. 192 (2)

[330] Ivi, Art. 192 (2) (b)

[331] Ivi, Art. 193

[332] Nilsson, M., (2018) European Union and global climate change. In: Wallace, D., & Silander, D., (eds.) *Climate Change, Policy and Security: State and Human Impacts*. Abingdon, New York, Routledge, p. 132

[333] European Commission *White Paper. Adapting to Climate Change. Towards a European framework for action*. COM/2009/147/4 [online] Available at: https://ec.europa.eu/health/ph_threats/climate/docs/com_2009_147_en.pdf

[334] European Commission Communication No 2013/216 to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. *An EU Strategy on adaptation to climate change* (16 April 2013), COM/2013/216 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0216&from=EN

to drought seasons, heatwaves and sea-level rise. Mountain areas, densely populated floodplains, coastal zones and outer regions are extremely exposed. Additionally, three quarters of the European population live in urban areas, vulnerable to heatwaves, extreme weather events, flooding and rising sea levels, often poorly prepared for these threats and thus for climate adaptation. [335] Certainly, Europe has a more tempered weather if compared to many other regions more exposed to environmental threats. Nevertheless, planning for weather-related disasters will become progressively important worldwide. In this sense, the European Union's 2013 Adaptation Strategy focused on climate proofing activities, rendering European's infrastructure more resilient and prepared, supporting adaptation actions with risk-management policies and assessment.[336]

In the last decades, the European Union have implemented numerous initiatives to tackle global climate change, both at adaptation and mitigation level. In 2013, Decision No 1385/2013/EU of the European Parliament and the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 "Living well, within the limits of our planet" established the Seventh EU Environment Action Programme with the purpose of supporting the EU in delivering actions on the environment and climate change up to and beyond 2020.[337] Amongst its objectives, enhancing the Union's natural capital, turning the EU in a low-carbon, green and resilient economy, increasing the EU'S effectiveness in addressing climate-related challenges, boosting the sustainability of the Union's cities.[338] Afterwards, Regulation No 1293/2013 established the Programme for the Environment and Climate Action (LIFE). The LIFE agenda set out its goals for the period 2014-2020 in Article 3 and include the shift toward a carbon-neutral and resilient economy, the enhancement on the implementation of EU's climate policies, the support to environmental governance at all levels and the strengthening the implementation of the 7th Environment Action Programme.[339] In April 2021, Regulation (EU) 2021/783 of the European Parliament and of the Council laid down the Programme for the Environment and Climate Action (LIFE) by abrogation of Regulation (EU) No 1293/2013.

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[335] Ibid

[336] Nilsson, M., *op. cit*., p. 134

[337] European Environment Agency (EEA), (n.d.) *7th Environment Action Programme*, [online] Available at: https://www.eea.europa.eu/policy-documents/7th-environmental-action-programme

[338] European Parliament and the European Council Decision No 1386/2013/EU *on a General Union Environment Action Programme to 2020 "Living well, within the limits of our planet"* (20 December 2013) Official Journal No 354/171. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D1386

[339] European Parliament and the European Council, Regulation No 1293/2013 *on the establishment of a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EC) No 614/2007* (11 December 2013) Official Journal L 347/185

The new LIFE project is intended to cover the 2021-2027 period and by pursuing the targets set by the European Green Deal – which will be addressed shortly - it should contribute "to a just transition towards a sustainable, circular, energy-efficient, renewable energy-based, climate-neutral and resilient economy, to the protection, restoration and improvement of the quality of the environment […]"[340]

More recently, the EU has launched one of the most ambitious frameworks for the fight against climate change. The European Green Deal represents a new strategy aiming at supporting the EU in the forthcoming environmental challenges, conserving the EU's natural capital, and safeguarding the health and well-being of its citizens, transforming it in a prosperous environment where net greenhouse gas emissions are erased by 2050 and therefore rendering Europe the first climate-neutral continent.[341] The European Green Deal proposes to foster an integrated and science-based approach, bringing all sectors together in order to align them on the same track towards a common goal. Certainly, new measures on their own will not be enough to achieve the objective proposed by the Green Deal. In addition to launching new proposals, the European Commission will work with the Member States to boost EU's efforts to ensure that current legislation and policies relevant to the Green Deal are successfully enforced.[342] In the ambitious package of the European Green Deal, the European Climate Law transforms into law the proposition of the Green Deal establishing a binding framework for reducing anthropogenic greenhouse gas emissions reaching climate neutrality by 2050.[343] In order to reach this goal, the Regulation proposes intermediate climate targets - article 4 (1) – that is "[…] the reduction of net greenhouse gas emissions (emissions after deduction of removals) by at least 55 percent compared to 1990 levels by 2030."[344]

The European Climate Law contains in Article 5 specific provisions on climate change adaptation, which should be coherent between the Union and its Members, mutually supportive, and in accordance with Article 7 of the Paris Agreement. Articles 6 and 7 are on assessment of measures and progresses at the Union level and at the level of State Members, Article 9 on

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[340] European Parliament and the European Council Regulation No 2021/783 *Establishing a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EU) No 1293/2013* (29 April 2021), L 172/53. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2021:172:FULL&from=EN

[341] European Commission, *The European Green Deal* (11 December 2019) COM/2019/640 final. [online] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN

[342] Ibid

[343] European Parliament and the European Council Regulation (EU) 2021/1119 *of 30 June 2021 Establishing The Framework For Achieving Climate Neutrality And Amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')*, Official Journal L 243.

[344] Ibid

public participations, expressing the level of engagement of the civil society with the aim of empowering them to "take action towards a just and socially fair transition to a climate-neutral and climate-resilient society."[345] Based on the new European Climate Law, the Europe's 2030 Climate Target Plan proposes an emission reduction of 55 percent by 2030 compared to 1990 levels, a target proved to be both economic feasible and beneficial for Europe with the right measures in place.[346] Amongst its objectives, the Communication set a more cost-effective path to achieving climate neutrality by 2050, enhance the creation of green jobs and at the same time, encouraging international stakeholders to increase the ambition to curb the rise in global temperature to 1.5°C and thus avoiding the most severe consequences of climate change. [347]

In conclusion, it can be affirmed that the European Union has always been very active in tackling global climate change through binding and non-binding instruments at the EU level, both with regard to adaptation and mitigation measures. Many EU members have a long history of national environmental policies, sharing its competences on environmental matters with the Union, which develops binding and non-binding standards for member states following the internationally-accepted environmental law principles, i.e., the preventive action, the precautionary principle, and the polluter-pays principle.[348] It is widely acknowledged, especially considering the comprehensive actions developed and implemented in the last years, that the European Union intends to hold a leading role in the fight against climate change, becoming the first climate-neutral continent in the nearest future.

1.1 Forging a climate resilient Europe: the EU strategy on Climate Adaptation

The previous paragraph already introduced some of the EU's actions on climate change and climate adaptation. In 2007, the Commission of the European Communities drafted the Green Paper on adapting to climate change in Europe[349] followed by the 2009 White Paper on climate adaptation. It set out a framework to reduce the EU's vulnerability to the impact of climate

[345] Ibid

[346] European Commission, *Stepping Up Europe's 2030 Climate Ambition. Investing in a Climate-Neutral Future for the Benefit of Our People* (17 September 2020), COM/2020/562. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0562

[347] European Commission (2021). *2030 Climate Target Plan*. [online] ec.europa.eu. Available at: https://ec.europa.eu/clima/eu-action/european-green-deal/2030-climate-target-plan_en

[348] Nilsson, M., *op. cit.*, p. 240

[349] European Commission, *Green Paper on Adapting to climate change in Europe – options for EU action* (29 June 2007) COM (2007) 354 final.

change while enhancing resilience and adaptive capacity to environmental threats.[350] As a consequence, the European Union's 2013 Adaptation Strategy represents a follow-up of the aforementioned Papers. It includes a communication, various working papers of the Commission and a Green Paper on the insurance of natural and man-made disasters.[351] As stated earlier, the EU Adaptation Strategy aims at achieving a more resilient Europe, ready to cope with the impacts of a changing climate, developing a uniform approach and improving coordination between the Union and its Member States.[352]

The 2013 Strategy intended to pursue three core objectives, namely, to promote and support initiatives from Member States, to adopt climate-proof measures at the EU level, to promote a decision-making process based on improved data and knowledge.[353] Nevertheless, despite adaptation programs and actions being proposed and implemented at the EU level, it is strongly believed that more prompt interventions are necessary. In fact, halting all greenhouse gas emissions would not automatically translate into climate impacts reduction or termination. These will continue for decades, even if global and European efforts to curb greenhouse gas emissions prove effective.

Even radical temporary reductions of emissions, like those caused by the 2008 financial crisis or the economic disruption from the COVID-19 pandemic, have minor consequences on the overall path of global warming. Major international commitments to reach climate neutrality are increasing the likelihood of a best-case scenario, but even in that case, significant adaptation efforts would still be required.[354] The new adaptation Agenda aims to achieve the 2050 vision of a climate-resilient Union by rendering "adaptation smarter, more systemic, swifter, and by stepping up international action."[355] Achieving smarter adaptation through improving knowledge and data assessment - especially on climate-related risks – and making the climate-ADAPT the authoritative European platform for adaptation. The Climate-ADAPT already covers a leading role in EU adaptation, incorporating EU scientific database such as the

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[350] European Commission *White Paper: Adapting to climate change: Towards a European framework for action* (1 April 2009) COM (2009) 147 final.

[351] Franceschelli, F., *op. cit*., p. 318. To learn more: European Commission Communication No 2013/213 final, Green Paper on the insurance of natural and man-made disasters (16 April 2013). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0213

[352] European Commission Communication No 2013/216, *An EU Strategy on adaptation to climate change*, cit. par. 4, p. 5

[353] Franceschelli, F., *op. cit*., p. 318

[354] European Commission Communication No 2021/82, *Forging a climate-resilient Europe - the new EU Strategy on Adaptation to Climate Change* (24 February 2021), COM(2021) final [online] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2021%3A82%3AFIN

[355] Ivi, p. 4

Copernicus Climate Change Service. Yet, more action is necessary in expanding its capabilities, user and contributor base, and impact. It will spur the sharing of knowledge, good practices and resolutions, including from EU-funded plans, reaching out to and involving a new increasing network of actors.[356]

In making climate adaptation more systemic - given the pervasive impacts of climate change - three cross-sectional priorities: integrating adaptation into macro-fiscal policy, nature-based solutions for adaptation, and local adaptation action.[357] In addition, increasing supporting actions for international climate resilience and preparedness can be accomplished "by implementing comprehensive risk management approaches, through national or subnational adaptation and climate-resilient policies, in synergy with disaster risk management and environmental and social policies."[358] Lastly, the EU increased the spending target by 30 percent in its long-termed budget for the period 2021-2027, destined to climate action, in particular, adaptation process. This action is part of the speeding process of adaptation across the EU and its Members.[359] Part of this budget is directly funding programmes such as the European Agricultural Fund for Rural Development, the European Regional Development Fund, Horizon Europe, and so forth. [360]

Moreover, the European Investment Bank, one of the largest supporters of climate finance, aims to provide at least €1 trillion in climate-action investment in this decade to 2030, as part of the Green Deal Investment Plan, realizing three major objectives. First, supporting sustainable investments (in particular, InvestEU);[361] conceiving frameworks for private investors and the public sector; lastly, aiding public institutions in green projects.[362] There are an increasing number of EU countries that are making progress in adaptation measures and even better, in implementation processes. Of course, for these plans to be effective, they must play a two-level game, being implemented both at the national and local level. Most National Adaptation Strategies (NASs) and National Adaptation Plans (NAPs) acknowledge the role of local authorities in successful adaptation action, coupling cities or municipalities with other key sectors for adaptation. For instance, adaptation planning at the local level is mandatory

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[356] Ivi, pp. 5-7 To learn more on Climate-ADAPT: https://climate-adapt.eea.europa.eu and on Copernicus: https://www.copernicus.eu/en

[357] Ivi, p. 7

[358] Ivi, p. 19

[359] Ivi, p. 12

[360] Global Center on Adaptation (GCA), (2020) *State and Trends in Adaptation Report 2020*. Vol. 1, p. 71

[361] InvestEU is a EU's programme providing support to physical and human capital investment. To learn more: https://ec.europa.eu/growth/industry/strategy/hydrogen/funding-guide/eu-programmes-funds/investeu_en

[362] Global Center on Adaptation (GCA), (2020) *op. cit.*, p. 72

according to national provisions in Denmark, Croatia, Ireland, Sweden and the United Kingdom. In other countries, risk and vulnerability assessment need to be carried out, for instance, the Netherlands. Since 2018, Sweden has required all its municipalities to have a wide-ranging plan incorporating a risk assessment of damage to the built environment caused by climate-related events.[363] In 12 EU countries – Bulgaria, Czechia, Denmark, Estonia, France, Greece, Ireland, Italy, Latvia, Lithuania, the Netherlands and Portugal – national associations of municipalities are included among the stakeholders consulted during the design of NASs and NAPs.[364] In supporting adaptation measures amongst cities and local communities, national networks support the exchange of information between cities. The Swedish Association of Local Authorities and Regions (SALAR) coordinates a virtual network in order to exchange best practices knowledge and experiences on climate adaptation.[365] In Denmark, the Local Government Denmark (KL) is the association of 98 Danish municipalities to share knowledge on a series of matters, including adaptation solutions amongst Danish cities. A new national Mobile Team with focus on flooding and erosion has been established by the Ministry of Environment and Food to help sharing of information especially between municipalities.[366] In the Netherlands, the Dutch city network *Klimaatverbond*, which works on climate change mitigation and adaptation, share knowledge on adaptation with over 160 members, while officially supporting the Covenant of Mayors. The Portuguese Rede de *Municípios para* a *Adaptação Local às Alterações Climáticas* is a recent adaptation network of the Portuguese municipalities created in 2016 participating in the ClimAdapt.Local project, offering a forum for information exchange to its members.[367]

Sometimes, actions at the urban level are not enough when disruptive climate events affect actors and sectors on a more widespread basis. Additionally, many small municipalities lack capacity and expertise to address climatic events, and the regional level intervene as an intermediate step between national and local adaptation in many countries. Moreover, regional-

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[363] European Environment Agency (EAA), (2020), *Urban adaptation in Europe: how cities and towns respond to climate change*, EEA, Report No 12/2020, p. 90

[364] Ivi, p. 91

[365] European Commission Report No SWD (2018) 460, *Adaptation preparedness scoreboard Country fiches accompanying the Report on the implementation of the EU Strategy on adaptation to climate change* (12 November 2018) SDW/2018/460 final, p. 675 [online] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018SC0460&from=EN

[366] Ivi, p. 173 To learn more on Local Government Denmark https://www.kl.dk/english/ and on the Ministry of Environment and Food initiative https://www.klimatilpasning.dk/media/1174683/evalueringsrapport.pdf

[367] European Environment Agency, (2020) *op. cit.*, p. 96. To learn more on the ClimAdapt.Local project: https://eeagrants.org/archive/2009-2014/projects/PT04-0007

level adaptation planning is particularly important in adaptation planning when it comes to countries with federal structures (e.g., Germany, Belgium, Austria).[368] In this context, individual Regions often take initiative in order to support local and urban adaptation. The Italian Region of Emilia-Romagna created a regional forum on climate changes, to share transparency in adaptation and mitigation choices. The forum is divided in three areas, namely residents, companies and public administration, organizing formation and awareness campaigns to allow more engagement from residents and major manufacturing sectors.[369] Also, the *Piani Clima in Emilia-Romagna* is about local municipalities and urban areas engaged in building local adaptation plans, which are ultimately monitored by the web platform CLEXi – Emilia-Romagna Cross Platform for Climate and Energy policies monitoring and accounting.[370]

In Saxony, Germany, the EU LIFE LOCAL ADAPT[371] project support small and medium-sized municipalities and in enhancing the assimilation of climate adaptation measures at the local level. In Portugal, the Lisbon metropolitan area climate change adaptation plan (PMACC-AML) was concluded in 2018 and was co-financed by European funds, representing the operationalizing the European and national adaptation approaches at a metropolitan scale. Moreover, eight European Regions participate in the RegionsAdapt initiative run by the Regions4 Sustainable Development network by facilitating access to latest innovations, tools and best practices of regional adaptation.[372]

To better comprehend the heat stress problem, the city of Antwerp, Belgium, commissioned the mapping of present and future temperatures and thermal comfort in the city. The research results indicated that the urban heat island of Antwerp exacerbates the impact of climate change on the urban population. To cope with urban heat stress, adaptation measures at three different scales are put forth. Firstly, at the city-wide scale, the installation of green roofs is made mandatory for new or renovated buildings with a suitable roof, as are permeable and green parking lots. Its aim is also to boost isolation of public buildings. At the local scale, the thermal

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[368] Ibid

[369] Regione Emilia-Romagna, (2020) *Forum regionale cambiamenti climatici*, [online] Available at: https://ambiente.regione.emilia-romagna.it/it/cambiamenti-climatici/gli-strumenti/forum-regionale-cambiamenti-climatici

[370] Regione Emilia-Romagna, (2021) *Piani Clima*, [online] Available at: https://ambiente.regione.emilia-romagna.it/it/cambiamenti-climatici/temi/la-regione-per-il-clima/piani-clima. CLEXi is a platform of Italian Region Emilia-Romagna allowing to monitor the implementation of adaptation plans at the local and regional level https://clexi.ervet.ii

[371] The EU LIFE LOCAL ADAPT is a regional EU-funded project to prepare local and regional areas to adapt to climate change and improve their resilience. It includes six project partners from four European Member States (Austria, Czech Republic, Germany and Lativia). To learn more: https://life-local-adapt.eu/en/

[372] Ivi, p. 97. To learn more: https://racetozero.unfccc.int/team_member/regionsadapt-regions4/

comfort is improved by installing fountains and ponds, planting trees and creating parks in public spaces that are renovated. Finally, the implementation of heat forecast, and warning system are put in place to curtail the health impacts to individual citizens.[373]

In Košice and Trnava, Slovakia, the Carpathian Development Institute, in collaboration with local authorities conducted an assessment of vulnerability to high temperatures and heatwaves, taking into account social aspects and thus including the elderly and the children, those living in inadequately insulated buildings, and those relying on facilities such as nurseries, schools or nursing homes and being more vulnerable to heat stress. In Košice, the Mayor of the self-governed city borough of Zapad decided to prepare a climate adaptation plan. Zapad, a homogenous residential area, consists primarily of blocks of flats built from prefabricated elements and poorly insulated.[374] Amongst the most important measures adopted, the increase of green areas, renewal of existing parks and green spaces, use of climate-resilient tree species, restoration of blue infrastructure and water fountains. Other than ecosystem-based solutions, improved thermal insulation, shadowing of transparent openings, and quick warning system on heatwaves, in collaboration with the State Health Authority of Slovakia. At the same time, the city of Trnava adopted similar responses to climate change impacts. In particular, a former neglected open space bordering with apartment blocks, a kindergarten and a nursing home were renovated through removal of asphalt, planting of trees, the building of a fountain, and new benches.[375]

The city of Hamburg, Germany, is highly committed in giving its contribution to the national and international climate protection objectives, enhancing cooperation with both private and public stakeholders in implementing adaptation and mitigation agendas.[376] In attempting to achieve climate-neutrality, one of Hamburg's objectives is to become greener. In this context, Hamburg is the first city in Germany to have developed a comprehensive Green Roof Strategy, with the aim of planting a total of 100 hectares of green roof surface in the metropolitan area. In

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[373] Climate-ADAPT, (2021) *Adapting to heat stress in Antwerp (Belgium) based on detailed thermal mapping*, [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/adapting-to-heat-stress-in-antwerp-belgium-based-on-detailed-thermal-mapping/#adapt_options_anchor

[374] Climate-ADAPT, (2021) Soci*al vulnerability to heatwaves – from assessment to implementation to implementation of adaptation measures in Košice and Trnava, Slovakia* [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/social-vulnerability-to-heatwaves-2013-from-assessment-to-implementation-of-adaptation-measures-in-kosice-and-trnava-slovakia

[375] Ibid

[376] City of Hamburg, (n.d.) *Green, inclusive, growing city by the water: Perspectives on Urban development in Hamburg*, p. 44. Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/four-pillars-to-hamburg2019s-green-roof-strategy-financial-incentive-dialogue-regulation-and-science

this context, green roofs cool the surrounding and amplify humidity, reducing in turn the urban heat cup. Besides, green roofs keep buildings better isolated and therefore greater adaptation to more extreme temperatures.[377]

Fig 2 - Green roofs in Hamburg (© BUKEA / Isadora Tast)

It is worth mentioning that the city of Hamburg is highly vulnerable to storm surges and flooding risks, due to its proximity with the North Sea and the River Elbe. In this sense, more suitable adaptation measures are adopted to protect the city and its residents from water-related hazards. However, the Green Roof Strategy improve water management by retaining rainwater and natural evaporation. They hold between 40 and 90 percent of stormwater, most of which evaporates and returns directly to the natural water cycle, diminishing the burden on the sewage system. The Green Roof Strategy therefore completes the city's Rain InfraStructure Adaptation 2030 project (RISA), which is the city's policy for the sustainable management of rainwater[378] Green roofs and spaces represent a sustainable tool softening the impacts of climate change in numerous ways, from absorbing CO_2 and reducing the city carbon footprint, to reducing the impact of heatwaves and naturally managing rainwater.

In conclusion, it can be stated that climate change impacts are increasing and at the same time, worsening, rendering climate adaptation actions imperative both at the national and local level. Despite the copious progresses that has been achieved in the climate adaptation field, more is required from the European Union and its Member States. In this sense, EU action on

[377] Climate-ADAPT, (2021) *Four pillars to Hamburg's Green Roof Strategy: financial incentive, dialogue, regulation and science* [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/four-pillars-to-hamburg2019s-green-roof-strategy-financial-incentive-dialogue-regulation-and-science

[378] Ibid

adaptation translates into the implementation of the measures that the European Green Deal sets for the EU with a precise goal of integrating local, indigenous and scientific expertise as well as gender-responsive planning and implementation.[379]

1.2 Urban initiatives for resilient cities at the European level

Cities cover nearly three percent of the Earth, yet they generate approximately 72 percent of the overall greenhouse gas emissions. In Europe, it is estimated that by 2050 almost 85 percent of European dwellers will be living in cities. Therefore, it is imperative that the climate emergency must be addressed b cities and by citizens.[380] At the European level, there are numerous initiatives supporting smart and green development in cities, through sharing of knowledge, funding and public and private participation. Amongst the milestone in the European urban agenda, the 2007 Leipzig Charter on Sustainable European Cities was adopted by the European Ministers for Urban Development and Regional Planning with the goal of protecting, strengthening and supporting the growth and development of EU's cities through sustainable development.[381] Its main task was to create high-quality public spaces, infrastructures and services with the joint cooperation of national governments, local authorities, citizens and businesses. EU cities must also be able to adapt to the challenges posed by climate change, especially through smarter transportation, energy-efficient infrastructures, proactive innovation and educational policies.[382] The Leipzig Charter inspired numerous Urban policies throughout Europe, representing the very basis of EU sustainable development for urban areas. However, since its draft in 2007, many transformations and changes occurred, starting from the 2008 financial crisis, the intensification of climate change impacts, to the latest COVID-19 pandemic, threatening the livelihoods of many urban dwellers and bringing to the surface demographic problems, social and economic inequalities, migration patterns, thus demonstrating that a more sustainable way of living is imperative. For these reasons, under the German Presidency, the original Leipzig Charter needs to be reviewed, taking into consideration the UN 2030 Agenda for Sustainable Development, with specific regard to the

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[379] Global Center on Adaptation (GCA), (2020) *op. cit.*, p. 77

[380] European Commission, Directorate-General for Research and Innovation, Gronkiewicz-Waltz, H., Larsson, A., Boni, A., et al. (2020) *100 climate-neutral cities by 2030 - by and for the citizens: report of the mission board for climate-neutral and smart cities*, p. 5. Publications Office. https://data.europa.eu/doi/10.2777/347806

[381] European Ministers for Urban Development and Regional Planning, (2007) *Leipzig Charter on Sustainable European Cities*, preamble.

[382] Ibid

SDG #11 making cities and human settlements inclusive, safe, resilient and sustainable, the New Urban Agenda, the Paris Agreement and the EU Green Deal.[383]

The new Charter divides European cities in three spatial levels, the neighborhood level reflecting social tensions, poverty and environmental stresses; the local authorities level, which is the intermediary between small-scale neighborhood and wider functional areas; and the functional area level.[384] In paragraph B.2 the Charter enlist three dimension of EU cities -just, green and productive city - where urban growth is based on the integration of social, ecological and economic dimension of sustainable development.[385] The Charter continues reporting the key principles of good urban governance, stressing that a balanced, integrated transformation of cities will only be thriving if governmental and non-governmental actors alike, work together. Paragraph D stress the importance to empower cities to transform and develop, to reach their best-selves, through adequate policy framework and funding.[386] The renewed Leipzig Charter should enable cities "to act as a benchmark for the practical implementation of various urban policies in all Member States, and thus helping to strengthen the credibility of the European project from the point of view of the people that are closest to it."[387]

At the basis of the New Leipzig Charter lies the 2016 Urban Agenda for the EU, striving to create a framework involving European authorities in achieving better regulation, better funding and better knowledge, representing the core of the present Agenda.[388] The EU URBAN Agenda was established through the Amsterdam Pact, which embraces a sustainable and comprehensive approach to address urban challenges. It should, in line with the Leipzig Charter, concentrates on all major aspects of urban development in order to guarantee sound urban governance and policy. Also, the EU Urban Agenda widely acknowledges the polycentric structure of Europe and the diversity of its cities.[389] As stated earlier, the Agenda focuses specifically on three pillars of EU policymaking and implementation, i.e., better regulation, funding and knowledge. Firstly, the EU Urban Agenda focuses on a more valid and coherent

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[383] European Ministers for Urban Development and Regional Planning, (2020) *The New Leipzig Charter – The transformative power of cities of the common good*, preamble. Available at: https://ec.europa.eu/regional_policy/sources/docgener/brochure/new_leipzig_charter/new_leipzig_charter_en.pdf

[384] Ivi, subpar B.1

[385] Ivi, subpar. B.2

[386] Ivi, pars. C and D

[387] European Committee of the Regions Opinion No 2020/C 440/20, *The renewal of the Leipzig Charter on Sustainable European Cities* (18 December 2020), Official Journal C 440/119, Volume 63, point 9

[388] European Ministers Responsible for Urban Matters Informal Meeting establishing *the Urban Agenda for the EU "Pact of Amsterdam"* (30 November 2016), p. 3

[389] Ivi, p. 4

implementation of existing EU policies, legislation and tools. Secondly, the Agenda will contribute to supporting, integrating, and improving sources of funding for Urban Areas. Lastly, the Agenda will enhance the knowledge base on urban matters and sharing of best practices and expertise.[390] To conclude, the Pact of Amsterdam asserts that "the Urban Agenda for the EU is a coherent set of actions of key European actors. It is a new form of informal multilevel cooperation where Member States, Regions, representatives of Urban Authorities, the European Commission, the European Parliament, the Union's Advisory Bodies (CoR, EESC), the EIB and other relevant actors work in partnership."[391]

The 2007 Leipzig Charter, the EU Urban Agenda, and the New Leipzig Charter represent the correlated and coherent action of the European Union in rendering cities green, equitable and safe hubs, enhancing transparent collaboration between its institutions and its stakeholders. In particular, the EU Urban Agenda and the New Leipzig Charter are strictly interconnected, being the New Leipzig Charter accompanied by an implementing document that "reaffirms the objectives and achievements of the Pact of Amsterdam, thus linking the Urban Agenda for the EU's working method to the New Leipzig Charter's strategic principles."[392]

In the field of resilient cities, Mission Board for Climate Neutral and Smart Cities introduced the Climate City Mission attempting to achieve climate neutrality by 2030. More specifically, after a consultation with EU residents throughout many European cities, the Mission Board proposed the 100 climate neutral cities by 2030 – by and for the citizens aiming at supporting promoting and illustrating 100 European cities in their systemic transition towards climate neutrality by 2030, making these cities innovating hubs for all cities.[393] It is well acknowledged that the main obstacle to climate transition is the failure of implementation rather than the lack of climate-friendly technologies. Therefore, a systemic transformation is required, based on three principles, namely a holistic approach to foster innovation, a multi-layered governance and constant partnership between stakeholders. In the Climate City Missions, the role of citizens will be pivotal, their involvement and participation not only as political actors, but as users,

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[390] Ivi, p. 6

[391] Ivi, p. 9

[392] European Ministers for Urban Development and Regional Planning, (2020) *Implementing the new Leipzig Charter though multi-level governance – Next steps for the Urban Agenda for the EU,* (30 November 2020), Available at: https://ec.europa.eu/regional_policy/sources/docgener/brochure/new_leipzig_charter/new_leipzig_charter_implem_en.pdf

[393] Gronkiewicz-Waltz, A., et al., (2020) *op. cit.*, p. 5 [online] Available at: https://ec.europa.eu/info/publications/100-climate-neutral-cities-2030-and-citizens_en

consumers and producers.[394] In doing so, they can have a massive impact on the environment, holding an active role in their local urban areas, associations and homes, thus more easily contributing to the climate transition and the improvement of the economy. For the Mission to succeed, citizens and the community must be given more substantial tasks, new platforms for action and better instruments. For instance, new initiatives and tools to facilitate the cooperation and work of citizens and stakeholders are the Covenant of Mayors network, the Green City Accord, the European Green Capital Cities, the Climate City Contract. The former was proposed by the Mission Board as a new mechanism to provide EU support to cities in the form of more innovation, better regulation and comprehensive financing.[395] The Objectives of the Mission is to promote residents participations through more bottom-up approaches and new forms of governance, foster a fair transition bringing numerous benefits – new jobs, improved air quality and lifestyle – following the goals and principles of the European Green Deal alongside the 2030 Agenda of Sustainable Development.[396]

The current Covid-19 pandemic has revealed numerous shortages and weaknesses, making it imperative to accelerate the transition towards more resilient and efficient cities. Urban areas are the melting-pot where diplomatic, economic and cultural exchanges take place, where long-lasting connections are made. However, cities are now in urgent need of an economic restart, and these centers on Europe's climate challenge, other than the Covid-19 health crisis. These will be the decisive test of Europe's ability to accomplish the twin ambition of short-to-medium term economic recovery post-COVID and longer-range climate neutrality. To achieve both, there is the demand to optimize the synergies between these objectives.[397]

At the EU level, the Smart Cities Marketplace is a large market-changing undertaking pledging to bring cities, industries, small-medium enterprises (SMEs), investors, researchers and many other smart city actors together. It was created by the merging of two former platforms, the Marketplace of the European Innovative Partnership on Smart Cities and Communities (EIP-SCC Marketplace) and the Smart Cities Information System (SCIS).[398] Under the umbrella of the Smart Cities Marketplace, the European Commission attempts to bring together all actors in the European Smart City community to aid citizens, cities, research

[394] Ibid
[395] Ivi, pp. 7, 5
[396] Ivi, p. 7
[397] Ivi, p. 29

[398] European Commission, (2019) *Smart cities*. [online] European Commission. Available at: https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

institutions and industry conveying more sustainable, resilient and smart urban areas, especially through sharing of knowledge and inspiration.[399]

There are numerous projects and initiatives all across Europe launched and funded by the Smart Cities Marketplace. The City of Grenoble, France, member of the Covenant of Mayors since 2008 and awarded as EU Green Capital 2022, is fully engaged in reducing energy consumption since the Grenoble Local Climate Plan was launched in 2004. It encourages renewable energies and social solidarity, establishing alternative transportation systems and developing environmental, architectural and urban quality.[400] In order to do so, the municipality has developed the *Éco-cité* project in the north part of the town. Later, the Smart Cities Marketplace project City-ZEN aimed at transforming the *Éco-cité* area into a positive energy and carbon neutral district through retrofitting private buildings and social housing, creating a low-temperature heating and cooling network, and developing a territorial monitoring system to supervise and manage all energy flows, assessing the system's efficiency.[401] The most important lessons learnt in the context of the City-ZEN project is the importance of creating durable connections through the organization of peer meetings and exchanging ideas; planning time in a smart way, involving city dwellers in the organization of initiatives and implementation process.[402]

As part of the Horizon 2020 project [403], the Smart Cities and Communities Project (SCC-Project Cluster) is a European Programme gathering 18 projects across European municipalities to bring together cities, business, knowledge institutes and citizens to demonstrate solutions and business patterns that can be enlarged and replicated, leading to measurable outcomes such as new jobs and energy savings.[404] By raising cross-collaboration between stakeholders throughout Europe, the SCC-Project Cluster is prepared to demonstrate how smart actions can pave the way to attain climate neutrality in EU cities, in line with the next generation of strategies that will embark on even bolder objectives to achieving 100 Climate neutral cities by

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[399] European Commission, (2020) *Welcome to the Smart Cities Marketplace*, [online] Available at: https://smart-cities-marketplace.ec.europa.eu/news-and-events/news/2020/welcome-smart-cities-marketplace

[400] European Commission, (n.d.) *City-ZEN Site Grenoble*, [online] Available at: https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects/city-zen/city-zen-site-grenoble

[401] Ibid. To learn more on the City-ZEN projects: http://www.cityzen-smartcity.eu/home/reporting/deliverables/

[402] Ibid

[403] Horizon2020 is the biggest EU Research and Innovation programme ever, with approximately €80 billion of funding available over a 7 year-period from 2014 to 2020. To learn more: https://ec.europa.eu/programmes/horizon2020/what-horizon-2020

[404] The Smart Cities and Communities Projects (SCC-Project Cluster), (n.d.) Available at: https://smart-cities-marketplace.ec.europa.eu/sites/default/files/2021-09/Manifesto%20of%20Collaboration%202021.pdf

2030.[405] The projects are able to deliver solid evidence on reaching transformative urban projects combining energy-efficient retrofitting and new construction, neat mobility and logistics, large deployment of renewable energy sources, smart infrastructures and deep citizen engagement leading to improved quality of life, health, social cohesion, competitiveness, jobs and growth.[406] In this framework, the Scalable Cities is a city-led initiative**,** created under the lead of the European Commission and the European Climate Infrastructure and Environmental Executive Agency (CINEA)**,** with the purpose to create wide-ranging, long-term support for the cities in the Smart Cities and Communities Project Cluster.[407]

In the European context, the Eurocities project aims at helping more than 200 cities connecting with each other, sharing experiences and creating prosperous and smart urban environments. Eurocities supports and participate in numerous EU-funded projects, to foster smart and green transition of cities. For instance, the Scale-Up-Users-Centric and Data-Driven Solutions for Connected Urban Poles (SCALE-UP) is a four-year-Horizon 2020 Innovation Action that commenced in June 2021, in which three urban nodes – Antwerp, Madrid and Turku – joined forces to develop data-driven and user centric strategies to accelerate the adoption of smart, clean and inclusive mobility, through well-connected and multifunction urban nodes.[408] In the framework of Eurocities and as part of Horizon 2020, the Food Trails will allow the shared design of 11 pilot activities in participating cities to improve urban food policy. The intent is to make the "farm-to-fork journey" sustainable, to empower communities, encourage a zero-waste use of resources, promote environmentally friendly behavior and allow people to have healthy and regular habits.[409]

Created by a group of municipalities, Eurocities, Open and Agile Smart Cities (OASC), the European Network of Living Labs (ENoLL), and supported by the European Commission and the Committee of Regions, the Living-in.EU Movement was created in 2019 under the Finnish

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[405] Ibid

[406] Ibid

[407] European Commission, (n.d.). *SCALABLE Cities - Smart Cities Marketplace*. [online] Available at: https://smart-cities-marketplace.ec.europa.eu/scalable-cities

[408]European Commission, (n.d.). *Scale up user-Centric and dAta driven soLutions for connEcted Urban Poles - TRIMIS*. [online] Available at: https://trimis.ec.europa.eu/project/scale-user-centric-and-data-driven-solutions-connected-urban-poles

[409] Eurocities, (n.d.) *Projects – Eurocities*, [online] Available at: https://eurocities.eu/projects/ The 11 municipalities involved in the project are Bergamo, Birmingham, Bordeaux, Copenhagen, Funchal, Grenoble, Groningen, Milan, Thessaloniki, Tirana and Warsaw. To learn more: https://foodtrails.milanurbanfoodpolicypact.org/consortium/

Presidency and the Council of EU.[410] The Living-in.EU Movement is a cooperative platform for cities attempting to spur the development and use of digital solutions to tackle the growing set of global challenges that cities are encountering and will endure in the future. Digital solutions include approaches to smart urban mobility, renewable energies, sustainable housing, and most importantly, civic-led governance.[411] One of its most valuable initiatives is the Citizen Card, offering people the chance to access public services at their convenience, including special discounts and advantages. The main objective of this solution is to eventually develop a European citizen card, so that Europeans using a citizen card in their own city will be able to use it as well in other European cities. Gijon, Spain, introduced a citizen card back in 2002, being one of the first cities to do so and representing a major revolution at the time.

Today, with about 98 percent of its residents using it, the card has incorporated the daily life of Gijon's dwellers who use it to access and pay for more than 100 activities clustered under 20 services linked to the local administration.[412] Bratislava, Porto, Rotterdam, and Zaragoza as well are developing the citizen card experience for their residents, even if some obstacles are in the way. For instance, integrating services that are administered at regional or national level can end up being challenging. In Zaragoza, for example, to integrate the national railways system in the citizen card, the local administration had to negotiate with the national government to find an agreement, through the mediation of the metropolitan consortium of transport.[413] The objective of the project is to develop and design a white label Citizen Card method with Zaragoza and Gijon as mentor cities, with the final goal being the implementation of the citizen card. However, the Covid-19 pandemic has severely affected local governments agendas and the related budgeting, forcing city administrations to re-consider and re-design activities.[414] Another significant initiative at the European level is the URBAN2030-II Project, which represents an attempt at fostering the achievement of the UN Sustainable Development

[410] European Commission, (2022) *City initiatives* [online] Available at: https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives_en

[411] Bemmel, M. van (2019). *Join us in building the European way of Digital Transformation for 300 million Europeans.* [online] Living in EU. Available at: https://living-in.eu/

[412] Eurocities. (n.d.). *Europe, all in one*. [online] Available at: https://eurocities.eu/latest/europe-all-in-one/

[413] Ibid

[414] Dallau, A., & Noordzij, L., (2021) *Accessing European cities with a Citizen Card: Different cities, different needs*, Eurocities, pp. 9-10 [online] Available at: https://eurocities.eu/wp-content/uploads/2021/04/Eurocities-KSF-Lab-Citizen-Card-report-2021_2.pdf

Goals in European cities and regions. It mainly focuses on delivering methodological support and inspiring the design and realization of SDG Voluntary Local Reviews.[415]

Lastly, an important EU initiative in the field of urban areas, is the Green City Accord (GCA). Its aim is to strengthen green solutions for urban areas, circular economy to help cities become more resource efficient. The Green City Accord also strikes to build coherent action with other EU cities initiatives, supporting and helping the implementation of the European Green Deal and the UN Sustainable Development Goals.[416] The signature of the Accord stimulate cities to commit in addressing five aspects of environmental management: air, water, nature and biodiversity, circular economy and waste, and noise.[417] The GCA signatories pledged to improve air quality in cities following the World Health Organization's Air Quality Guidelines.[418] Later, cities commit to achieving solid progress in improving the quality and efficiency of water bodies, in enhancing urban biodiversity conservation, in advancing towards a circular economy pattern – by improving the management of municipal waste – and lastly, in reducing urban noise pollution.[419] After signing the Accord, the cities have two years to submit a first report, which should contain information on the point of departure on the five areas, the targets the city has proposed to meet by 2030, and an overview of the future steps employed to achieve these targets. Lastly, in order to monitor the Green City Accord's progress, a small set of mandatory indicators has been established.[420]

From the case samples and analysis of the present paragraph, it can be determined that a significant amount of urban initiative is established at the EU level, from projects funded and launched by the EU to bottom-up approaches established by the civil society or local administrations. What is certain, is that there is countless example, case studies and initiatives demonstrating how local authorities are becoming involved in rendering cities more habitable, fairer and greener. Indeed, as leaders of the Visegárd Group, Matúš Vallo, Mayor of Bratislava;

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[415] European Commission, (2021) *Localising the Sustainable Development Goals*, [online] Available at: https://urban.jrc.ec.europa.eu/sdgs/en/

[416] European Commission, (2020) Green City Accord: Clean and Healthy Cities for Europe, [online] Available at: https://ec.europa.eu/environment/publications/green-city-accord-brochure-0_en

[417] European Commission, (n.d.) *Green City Accord*, [online] Available at: https://ec.europa.eu/environment/green-city-accord_en

[418] European Commission (n.d.) *Five Priority areas*, [online] Available at: https://ec.europa.eu/environment/green-city-accord/five-priority-areas_en To learn more on the WHO Air Quality Guidelines: https://apps.who.int/iris/handle/10665/345329

[419] Ibid

[420] European Commission (n.d.) *Five Priority areas*, [online] Available at: https://ec.europa.eu/environment/green-city-accord/five-priority-areas_en

Gergely Karácsony, Mayor of Budapest; Zdeněk Hřib, Mayor of Prague; Rafał Trzaskowski, Mayor of Warsaw recently stated in an Eurocities article,

> "Where national governments refuse to act, cities can become the place where the fight for climate can be won. […] Together, we can accelerate the much-needed transformation and contribute to the milestone of making Europe the first climate neutral continent." [421]

2. Environmental changes in the European macro-region of the Baltic Sea: adaptation strategies in Scandinavian cities

It is now well established that climate change impacts are altering natural habitats and ecosystems as well as social systems and urban areas. The Baltic Sea Region[422] is certainly not amongst the areas that will be most severely affected by climate change. Yet, it is already experiencing impacts and the consequences of a changing climate.[423] Scientists and experts in the field have already predicted different case-scenarios. The Baltic Earth Assessment of Climate Change presented the medium-scenario where mean temperatures in the Baltic Sea Region are expected to increase by roughly 4°C only in the winter whereas the high scenario suggests 5-6°C warmer climate in wintertime and 4.5°C in summertime.[424] Consequently, the impacts of warmer temperatures will generate a series of chain-effects. Firstly, increased instability in all weather systems. Indeed, we are already witnessing more intense and frequent storms directly impacting ecosystems and human activities, particularly agriculture and horticulture.[425] Secondly, increased mean temperatures will cause the melting of ice polar caps and the damage a broad variety of ecosystems, including the habitats of plenty of species, finding it difficult to adapt to higher temperatures.

Lastly, shifts in precipitation patterns will be more frequent, resulting in less precipitations in dry areas and more intense ones in wet areas. Therefore, drought seasons and flood events will become more severe and recurrent.[426] Seasonal changes are also evident: the length of the growing season has increased, and the course of the cold season has lowered. For example, in

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[421] Vallo, M., Karácsony, G., Hřib, Z., and Trzaskowski, R., (n.d.). *Cities can bring balance to EU climate package*. Eurocities [online] Available at: https://eurocities.eu/latest/cities-can-bring-balance-to-eu-climate-package/

[422] The Baltic Sea Region comprehend the EU countries Denmark, North-East Germany, Poland, Lithuania, Latvia, Estonia, Finland and Sweden and non-EU countries Norway, Belarus and Nort-West Russia.

[423] Haldén, P., (2018) Geopolitics in the changing geography of the Baltic Sea Region: the challenges of climate, *Global Affairs*, 4(4-5), p. 537

[424] Ivi, p. 538

[425] Heldén, P., *op. cit.* p. 539

[426] Ibid

Tartu, Estonia, the amount of deep winter days (covered in snow) diminished by 29 over the twentieth century, whilst the growing season increased by 13 days. The Baltic Countries and Poland underwent a substantial increase in the number of hot days and nights and the incidence of heat waves, as well as a significant reduction in the number of frost days.[427]

What is more, the Baltic Sea Region have severely been polluted by industries and industrialized agriculture which have even ruined many of the regional and local ecosystems. For instance, large parts of the seabed are now dead because of lack of oxygen in the Baltic Sea, which in turn is caused by high levels of nitrogen and other pollutants that have been emitted from activities around the sea.[428] For centuries, cod has been the primary source of nutrition and income in the Baltic Sea area. Nowadays, cod populations have diminished dramatically. However, urban and rural dwellers in the Baltic Sea Region do not rely on cod as they used to, since they can obtain food from other regions.[429] Currently, the Baltic Sea region presents weather conditions in constant variation due to its position in the extra-tropics of the northern hemisphere. The climate of the Baltic Sea basin is mainly controlled by the prevalent air masses, in turn atmospheric conditions are controlled both by global climate and by regional circulation patterns.[430] In addition, the semi-closed shape of the Baltic basin and due to land uplifting, local conditions influence the weather as well. Due to the changing environmental patterns, it is becoming more and more difficult for communities to adapt. Indeed, in the shorter-term, low-lying parts of the coast will experience more frequent temporary flooding caused by a combination of sea-levels rise and higher recurrence of storm surges, which are widespread in the Baltic Sea, with the eastern area being more vulnerable than the western one.[431]

The Baltic Sea region has always established regional and international networks and cooperation in many policy areas, such as the Marine Strategy Framework Directive, the Common Agricultural Policy and the Common Fishery Policy.[432] In the European context the 2009's European Union Strategy for the Baltic Sea Region (EUSBSR) attempted to address those challenges that the national and local sphere were not able to address. Among the key challenges that are tackled by the EUSBSR, to enable environmental sustainability, the

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[427] Von Storch H., et al., (2015) Introduction and Summary. In: The BACC II Author Team (eds) *Second Assessment of Climate Change for the Baltic Sea Basin*, Heidelberg, Germany, Springer Cham, p. 1

[428] Ivi, p. 541

[429] Ibid

[430] Von Storch H., et al., *op. cit.*, p. 1

[431] Heldén, P., *op. cit.* p. 544

[432] European Commission Communication No 2009/248 final, *European Union Strategy for the Baltic Sea Region*, (10 June 2009), COM(2009)/ 248 final. Available at: https://ec.europa.eu/regional_policy/sources/docoffic/official/communic/baltic/com_baltic_en.pdf

development of the region's prosperity, to increase accessibility and attractiveness and lastly, to ensure safety and security throughout the region.[433] Later, the INTERREG Baltic Sea Region (BSR) Programme 2014-2020 strengthen territorial collaboration and development for the Baltic Sea Region. The agenda has the purpose of tackling those issues that cannot adequately be dealt with by individual countries, thus representing a follow-up of the EUSBRS, supporting its implementation.[434] The BSR Programme follows four main objectives, the capacity for innovation, an efficient management of natural resources, sustainable transport and macro-regional cooperation. Consequently, the second priority – concerning the environment – includes five main objectives, improved water management, greater use of sustainable renewable energy, increased energy efficiency and resource- effective blue growth.[435]

The INTERREG Baltic Sea Region is developing the 2021-2027 Programme yet to be implemented which creates a framework for public and private collaboration across borders and on smart objects, aiming at the application of resilient, innovative, water-smart and climate-neutral solutions to benefit the citizens across the Baltic Sea Region. The four priorities of the 2021-2027 Programme are to enhance innovative societies, to create water-smart solutions, to strengthen climate-neutral societies and to spur cooperative governance.[436] It can be generally understood that climate change represents a priority for the Baltic Sea Region since the first EUSBSR Action Plan in 2009. Later in 2013-2014 the plan Horizontal Action "Sustainable Development" incorporated climate change while in 2015 the Horizontal Action Climate of the EU strategy for the Baltic Sea Region was introduced in the revised version of the EUSBSR agenda.[437]

At the international level, the Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area seeks to cope with the rising environmental challenges from industrialization to anthropogenic activities severely affecting the marine environment. The parties pledged to protect the Baltic Sea basin from any source of pollution, adopting measures to preserve natural habitats, and biological diversity, its ecological balance and lastly, the sustainable management of marine resources.[438] Firstly signed in 1974, the Convention was established alongside the Baltic Marine Environment Protection Commission (also known as

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[433] Ibid

[434] Climate-ADAPT, (n.d.) *Baltic Sea*, [online] Available at: https://climate-adapt.eea.europa.eu/countries-regions/transnational-regions/baltic-sea-region

[435] Ibid. To learn more: https://interreg-baltic.eu/ongoing-projects/programme-2014-2020/

[436] Interreg Baltic Sea Region, (n.d.) *Thematic Overview - Priorities 2021 - 2027*. [online] Available at: https://interreg-baltic.eu/get-funding/priorities-2021-2027/

[437] Climate-ADAPT, (n.d.) *Baltic Sea*.

[438] HELCOM (n.d.) *The Helsinki Convention*, [online] Available at: https://helcom.fi/about-us/convention/

Helsinki Commission or HELCOM), an intergovernmental organization and a regional platform for the protection and policy making of the environment.[439] In addition, the Council of the Baltic Sea States (CBSS) is an intergovernmental political forum enhancing cooperation in the Baltic Sea Region adopting a global perspective to address regional challenges. These include the political application and implementation of the UN Sustainable Goals, the Paris Agreement. The Sendai Framework on Disaster Risk Reduction and the UN Convention on the Rights of the Child.[440]

On the adaptation level, the Baltadapt project, financed under the INTERREG Baltic Sea Programme 2007-2013, developed an adaptation agenda for the region with specific guidelines and a non-binding action plan. It intends to augment national and sub-national adaptation operations in the Baltic Sea region, in particular by the improvement of coordination across levels and sectors with the aid of information exchange and networks development.[441] On a more local basis, the Union of the Baltic Cities (UBC) is the leading network of the Baltic Sea Region municipalities, enhancing collaborative action on multiple issues, including cultural preservation, sustainable environment and creating youthful cities.[442] The UBC is involved in numerous projects with other stakeholders, both at the regional level and in the international arena. For instance, the NOAH project improves spatial planning and the operation of urban storm water outflow and drainage systems with the purpose of reducing pollution arising from extreme weather conditions, from heavy rains to floods. NOAH elaborates a new layer for extreme weather events to be employed in computer-based shaping of drainage. The combination of traditional urban planning with this modelling translates into a holistic approach to tackle climate change impacts.[443] In October 2021 during the UBC XVI General Conference, the Union of the Baltic Cities Sustainability Action Programme 2030 was adopted. Albeit many UBC cities are already pioneers in sustainable and green solutions, more ambitious and wide-ranging climate goals and tangible actions are required from UBC cities.[444] The general focus

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[439] HELCOM, (n.d.) *About us* – HELCOM [online] Available at: https://helcom.fi/about-us/ The Helsinki Commission has ten Parties, Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

[440] CBSS, (n.d.) *About Us* [online] Available at: https://cbss.org/organisation/about-us/

[441] Climate-ADAPT, (n.d.) *Baltic Sea*.

[442] Union Baltic Cities, (n.d.), Available at: https://www.ubc.net

[443] Union Baltic Cities (n.d.). *NOAH project* [online] Available at: https://www.ubc.net/content/noah-project To learn more on the NOAH project: https://sub.samk.fi/projects/noah/

[444] Union of the Baltic Cities Sustainable Cities Commission, (2021) *UBC Sustainability Action Programme 2030: Cities together for a sustainable Baltic Sea Region*, UBC, p. 5. Available at: https://www.ubc-sustainable.net/sites/www.ubc-environment.net/files/publications/ubc_sustainability_action_programme_2030.pdf

in the UBC Sustainability Action Programme 2030 is on climate approaches and the SDGs which are integrated in the five key topics, i.e., water-smart cities, mobility-smart cities, energy-smart cities, biodiverse cities and resource-efficient-cities. These objectives want to set an example for other municipalities to follow, in order to mold young and efficient leaders to building climate-resilient areas.[445] In reaching zero-pollution target and an efficient water-managed ecosystem, cities pledge to ease pollution and restore quality of water in the Baltic Sea, to safeguard the ecological health of water bodies, to secure water use in a more sustainable way.[446] The purpose of establishing biodiverse cities is to impose the restoration of forests, the creation of green areas and buildings in cities as part of climate change mitigation. In this sense, the EU Biodiversity Strategy 2030 sets green targets for cities, which are encouraged to develop urban greening plans, e.g., measures to create biodiversity, accessible urban forests, parks and gardens, urban farms, gardens and meadows. These initiatives are supported by actions such as the Green City Accord, in which the UBC covers the role of official supporter, encouraging member cities to join the agenda.[447]

The Baltic Sea territory can be identified as a pioneering region in fulfilling its regional and global responsibility by cooperating, raising awareness, sharing good practices and knowledge. In turn, municipalities also play an important role in the implementation and legislation of policies that will support the development of greener, smarter and healthier cities.[448] The next paragraph will describe in more detail the actions adopted by several Baltic Sea cities, taking, amongst others, Malmö, Stockholm and Copenhagen as leading examples.

2.1 Smart-green cities: Malmö and Stockholm as pioneers of climate-resilient actions

Situated in the Baltic Sea Region, Sweden is not immune to environmental change impacts, being particularly exposed to storm surges, flooding, extreme weather events. In particular, land rise is taking place in most of the Country as a consequence of the melting of land ice, resulting in the reduction of the albedo effect (i.e., the ability of a light surface of reflecting solar radiations).[449] Moreover, the increases in atmospheric temperature and the incidence of heatwaves will accelerate coastal erosion through rising sea levels, especially in the Southern

[445] Ivi, p., 6
[446] Ivi p. 13
[447] Ivi, p. 14 To learn more on the EU Biodiversity Strategy 2030: https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en
[448] Ivi, p. 26
[449] Climate-ADAPT, (n.d.) *Sweden* [online] Available at: https://climate-adapt.eea.europa.eu/countries-regions/countries/sweden

coast.[450] The city Malmö is situated in the South-West part of Sweden, in the Öresund bay facing Copenhagen. As many other cities, Malmö is experiencing the adverse consequences of climate change due to increase in mean temperatures and extreme rainfall. Thus, the city attempts to achieve climate adaptation measures by incorporating it directly in the design and development of urban projects.[451] For instance, the suburb of Hyllie, on Malmö's urban periphery, has discovered itself as the protagonist of efforts to engage with the emerging trends of smart urbanism, representing a spot within which the objectives of examining smart interventions and realizing low carbon transition can be achieved.[452]

After an economic decline caused by the closing of the city's shipyard in the 1980s, in 1994 the new Mayor Ilmar Repaalau launched the Project Malmö 2000, with the intent of achieving economic competitiveness. Focused on the former shipyard area, Western Harbour, this strategy contained plans for its development through a housing exhibition, the Bo01.[453] A real turning point occurred throughout the 1990s when the Hammarby Sjöstad development in Stockholm began to attract international attention, allowing Sweden and Stockholm more in general, to be positioned as the "cutting edge of sustainability." The designs, ideas and innovations coming from the Hammarby Sjöstad started to spread within Sweden, influencing the work of architects, urban developers and professional planners strengthening the possibility of Malmö exiting its economic difficulties through the new development of sustainability.[454] This was further accelerated by the spread of national infrastructure projects, which bridged (concretely and metaphorically) the Öresund developing a rail network between Malmö and Copenhagen, transmitting a sense of modernity to the region and bringing closer the city to its Danish neighbor and reinforcing its global reputation for sustainable development.[455] Later in 2000, the Bo01 was completed, representing one of the most outstanding forms of sustainable urbanism in Europe, contributing to leverage new flows of European funding – with the municipal administration well located to be the partner of numerous projects other than

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[450] Ibid

[451] Climate-ADAPT, (2021) *Optimization of the mix of private and public funding to realize climate adaptation measures in Malmö*, [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/optimization-of-the-mix-of-private-and-public-funding-to-realise-climate-adaptation-measures-in-malmo

[452] Bulkeley, H., and Stripple, J., (2020) Climate Smart City: New Cultural Political Economies in the Making in Malmö, Sweden, *New Political Economy*, p. 6

[453] Ibid

[454] Ibid. The Hammarby Sjöstad is an urban district containing a right balance of sustainable residential development. To learn more: http://dcfw.org/hammarby-sjostad-stockholm-sweden/

[455] Ivi, pp. 6-7

attracting international interests and stakeholders.[456] Today Western Harbour offers many different services. Several headquarters – including the Malmö University head office - and businesses, amongst other media societies, environmental techniques and contractors have established themselves in the district. The objective for the Western Harbour to be an example of sustainable urbanization has been obtained. Yet, the area is far from complete and has still the potential to continue to evolve into an even more sustainable urban neighborhood with a high quality of life.[457] Following this example, the Hållbarheten was built by the European electric power company E. ON, in the shape of a multi-family apartment building in Malmö, Western Harbour. The residence, which utilize a variety of renewable heating solutions – Solar PV, Biogas and Heat Pumps – enable the residents to produce, monitor and control their own energy. Every apartment has 50 measuring points, supplying information on the temperature and energy usage, and it includes an electronic device monitoring and regulating the use of energy and the relative costs.[458]

Between the 1980s and 1990s, the district of Augustenborg in Malmö was characterized by social and economic decline and has suffered recurrent flooding due to a malfunctioning drainage system. Later on, the area was regenerated, including the establishment of sustainable urban drainage systems (SUDS) and 6 kilometers of water conduit and ten retention ponds.[459] Rainwater is gathered in natural ditches and tanks whilst the surplus is directed to a standardized sewer system and a nearby watercourse. The storm water from roofs, roads and car parks is being channeled through visible trenches, ditches, ponds and marshlands. To further support the drainage system, starting from 1998 green roofs were developed on all new buildings (built post-1998) and installed on some older construction presenting specific characteristics.[460] The restoration works in Augustenborg started in the 1990s, under the Ekostaden (Eco-city) Augustenborg project. The key objective of the proposal was to create a more socially, economically, and environmentally sustainable neighborhood. The project intended to address the matter of urban flooding in combination with measures that could reduce CO_2 emissions, and at an upgraded waste management system.[461] Clearly, the regeneration of the draining

[456] Ivi, p. 7
[457] City of Malmö, (2021) *Western Harbour* [online] Available at: https://malmo.se/Welcome-to-Malmo/Sustainable-Malmo/Sustainable-Urban-Development/Western-Harbour.html
[458] Bulkeley, H., and Stripple, J., *op. cit.*, p. 10
[459] Climate-ADAPT, (2021) *Urban stormwater management in Augustenborg, Malmö,* [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/urban-storm-water-management-in-augustenborg-malmo
[460] Ibid
[461] Ibid

system and the expansion of green areas and rooftops has visibly improved the social and economic condition of the Augustenborg district, developing into a green and inclusive area near the city center. Recently, the city of Malmö has been the protagonist of the first round of Climate Contracts Malmö, a signed contract between actors in the construction, transport, energy, and waste sector together with the Municipality. The contract has the purpose of gathering ideas and initiatives to achieve the goal of a sustainable and resilient Malmö by 2030 and meet the most compelling global challenges on a local level.[462] Last but not least, the municipality of Malmö will be hosting the ICLEI World Congress in May 2022.

The aforementioned case studies and the initiatives involving the city represent only a small portion of the centrality that characterize the city of Malmö as a sustainable hub. The Bo01 as well as the more recent Hållbarheten projects are intentionally used as a demonstration for different solutions of smart living. More specifically, they represent not only a site of economic development, but also a place of social and cultural reproduction of what it means being both "smart" and "low carbon." More in general, the city of Malmö represents a case in which climate become a "means through which economies are being made."[463]

Stockholm, the capital of Sweden, is a city surrounded by lakes, water and little islands situated in the Eastern part of the country and is widely recognized as one of the greenest and most sustainable capitals in the European context – if not in the international one. In 2010 it was awarded as European Green Capital by the European Commission, thanks to its clear and effective measure to reduce noise pollution, for its protection plans towards the environment, its innovative waste and disposal system, and for its incidence of green spaces, allowing 95 percent of its residents to live less than 300 meters from green spaces.[464] The City of Stockholm has always adopted a holistic vision, combining growth with sustainable development for the benefit of its urban dwellers. Transport emissions are comparatively low, and all trains and inner-city buses operate on renewable fuels. In addition, greenhouse gas emissions have been reduced by 25 percent since 1990, and the city council has the far-reaching goal of becoming independent from fossil fuels by 2050.[465] In 2019, at the "Smart City Expo World Congress" held in Barcelona, the city of Stockholm received the Smart City Award for its GrowSmarter project which enhanced "innovation, openness and connectivity "and efforts in rendering the

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[462] City of Malmö, (2021) *The first round of Climate Contacts Malmö is signed,* [online] Available at: https://malmo.se/Aktuellt/Artiklar-Malmo-stad/2021-12-23-Forsta-omgangen-av-Klimatkontrakt-Malmo-ar-signerade.html

[463] Bulkeley, H., and Stripple, J., *op. cit*., pp. 10-11

[464] European Commission (2010) *European Green Capital*, [online] Available at: https://ec.europa.eu/environment/europeangreencapital/winning-cities/2010-stockholm/

[465] Ibid

city a healthy and livable environment for its citizens.[466] The GrowSmarter was a 5-year project endorsed by the European Commission and led by the City of Stockholm, concluded in 2019. Its priority was to develop and implement smart and green solution to refurbishing areas of the city. The Project embedded three Lighthouse cities, Stockholm, Cologne and Barcelona and five other cities, Valletta, Suceava, Porto, Cork, and Graz. Indeed, the project was also supported by the EC's Smart Cities and Communities Horizon 2020 Program.[467]

The scope of the project was to demonstrate the validity of 12 solutions environmentally and economically sustainable in the Lighthouse cities; foster collaboration between cities, businesses and academia to import smart solutions all over Europe; improve European's quality of life. Through a holistic method, the 12 solutions aimed at meeting three fundamentals of sustainability, namely low-energy, integrated infrastructures and sustainable urban mobility.[468] In the first case, "more than 120,000 square meters of building spaces" were renewed with better energy efficiency by 60 percent and smart local energy improved networking fluctuations saving electricity. Secondly, integrated infrastructures envisaged smart streetlights, new systems of heating and cooling and smart data collection.[469] Lastly, sustainable urban mobility projected alternative-fueled vehicles, smart management of traffic, and smart transportation to reduce the carbon footprint. The GrowSmarter represents a first example of how Stockholm shares its experience and knowledge with other cities, establishing durable and valuable networks and fostering smart and green solution as a solution to reduce the impact of greenhouse gas emissions.[470]

In the 1990s was created what would become one of Stockholm's landmarks, the district of Hammarby Sjöstad, which embodied the city's largest urban development plan for many years. The neighborhood provides a natural enlargement of Stockholm's inner city – an element that has influenced the structure, framework, and construction design.[471] The district represents a real city in the city, characterized by a combination of closed and traditional inner city, with more modernistic and open planning style, and ultimately countersigned by sustainable materials such as glass, wood steel and stone.[472] Ecological options for managing water, energy

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[466] Landahl, G., (2021) Stockholm: Smart City. In: Juan Carlos Augusto (ed.) *Handbook of Smart Cities*, Springer, Cham, p. 296
[467] Ivi, p. 309
[468] Ibid
[469] Ibid
[470] Ivi, pp. 311-312
[471] Hammarby Sjöstad ekonomisk förening (HSEF), (n.d.) *Hammarby Sjöstad* [online] Available at: https://www.hammarbysjostad.se/en/hammarby-sjostad/
[472] Ibid

and waste were carefully studied since its first development both at the architectural and infrastructural level. For example, all the electricity employed comes from renewable sources and recent models of fuel cells, solar cells and solar panels are being tested and evaluated in the area. Concerning water management, the district is engaged in spreading more awareness on the matter among its residents, in order to learn the best practices for water saving and consumption.[473]

Another example of the comprehensive sustainability of the area is given by the treatment of wastewater, whereas "Wastewater is treated locally. The sludge produced by the treatment process is recycled and used for fertilizing farmland and forestry land. The waste releases biogas during processing. That biogas is used as fuel for vehicles such as buses, taxis and waste collection trucks, and to heat 1000 homes in the area."[474] Last but not least, rainwater infiltrates directly into the ground or is drained through canals, while it is also buffered by green roofs. Outflows from roads is captured independently and drained to treatment pools before permeating the soil.[475] Indeed, the district is enriched with roads, parks, quays, walkways, ponds all serving for the functioning of the whole system and being decorative traits of the area. Nowadays, Hammarby Sjöstad covers an area of nearly 150 hectares, where approximately 20 thousand people live and where another 10 thousand work.[476] The district of Hammarby Sjöstad represents a milestone in Stockholm's urban development, set as an example for cities at the European and international level, ensuring a sustainable and high quality of life for its residents. The city of Stockholm and its cutting-edge interventions are globally perceived as models to be followed and adopted. However, the city is already developing new sustainable targets to be met. The Strategy for a fossil-fuel free Stockholm by 2040 aspire at accelerating the cutting of CO_2 emissions integrating the climate goal into all municipal activities and assigning different responsibilities to municipal committees and boards of municipal companies to better coordinate actions and implementation.[477] For instance, the City collaborates with energy companies, hospitals and other infrastructures to gradually replace fossil oils with renewable

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[473] Urban Green-Blue Grids (n.d.) *Hammarby Sjöstad, Stockholm, Sweden*. [online] Available at: https://www.urbangreenbluegrids.com/projects/hammarby-sjostad-stockholm-sweden/

[474] Ibid

[475] Ibid

[476] Todescan, G., (2021) *Hammarby Sjöstad, il quartiere green di Stoccolma che ha conquistato Xi Jinping*, Cityvision, [online] Available at: https://city-vision.it/hammarby-sjostad/

[477] City of Stockholm, (2016) *Strategy for a fossil-fuel free Stockholm by 2040*, Ref. no. 134-175/2015, p. 7 Available at: https://international.stockholm.se/globalassets/rapporter/strategy-for-a-fossil-fuel-free-stockholm-by-2040.pdf

energy; it lobbies for provisions and legislation supporting a fossil-free transportation industry; it explores the potential for reducing plastic in incinerated waste and encourages the adoption of renewable and sustainable resources.[478] There is evidence that some fossils energy will still be employed in 2040, mostly in shipping and aviation, where the City's competence of intervention is narrowed, but also in the shape of fossil-based plastics in waste incineration venues.[479] However, the general strategies are deemed to be in line with the Stockholm Environment Programme, and thus, implemented in the City's integrated management system, whereas implementation is a responsibility of the respective municipal committee or of the board interested.[480] In the mobility sector, an important EU-funded project is the Civitas Eccentric, promoting innovative and sustainable solutions in transportation in peripheral urban areas. The project took place in five European cities, namely Madrid, Munich, Stockholm, Turku, Ruse, developing solutions with the aim of spurring the advancement of communications networks, for instance test for electric cargo bikes and electric vans were carried out in Stockholm.[481]

At the international level, the municipality of Stockholm has joined important international declarations. The Clean Air Cities Declaration pledged cities to set ambitious targets for reducing air pollution, implement substantial policies before 2025, and build up reliable-wide air quality monitor and assessment. In collaboration not only with local administrations, the signatories – Buenos Aires, Copenhagen, Dubai, Houston, Milan, Warsaw and many others – engage and cooperate with regional, supranational and national authorities as well.[482] In 2017, it was estimated that 13 percent of cities' total greenhouse gas emissions derived from food consumption in C40 cities, taking also in consideration that much of the world's food is consumed in cities and much more is projected to be consumed by 2050.[483] In this sense, Stockholm – alongside Barcelona, Copenhagen, Guadalajara, Lima, London, Los Angeles, Milan, Oslo, Paris, Quezon City, Seoul, Tokyo and Toronto - adhered to the Good Food Cities Declaration, aiming at managing and providing a healthy and balanced diet in accordance with

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[478] Ivi, pp. 8-10

[479] Ivi, p. 41

[480] Ivi, p. 45

[481] City of Stockholm, (n.d.). *Civitas Eccentric - Stockholms stad*. [online] Available at: https://start.stockholm/om-stockholms-stad/projekt/eu-projekt/programperiod-2014-2020/civitas-eccentric/ To learn more on the Civitas Electric Project: https://civitas.eu/projects/eccentric

[482] C40 Cities. (n.d.). *Clean Air Cities Declaration*. [online] Available at: https://www.c40.org/declarations/clean-air-cities/

[483] C40 Cities. (n.d.). *Good Food Cities Declaration*. [online] Available at: https://www.c40.org/declarations/food-declaration/

the demographic and cultural background of citizens. Indeed, the signing cities commits in foster organic sources of food, support plant-based consumption in urban areas and reducing waste of food.[484]

In line with major environmental landmarks – the Paris agreement and the UN Agenda 2030, for instance – Stockholm is fiercely working to achieve a fossil-free environment and to set the example for other international leaders. Its cooperation with important networks and stakeholders such as C40 Cities, the Global Covenant of Mayors and the European Union, also represents an example to be followed, demonstrating that joint action is required to address the climate crisis – and many other transnational challenges.[485]

2.2 Climate adaptation and strategies in Copenhagen: the UN17 eco-village

As a low-lying city with the highest ground around 45 meters above sea level, Copenhagen is an exposed city to the impacts of environmental changes, to the effects of natural and anthropogenic variations in sea level rise.[486] The city of Copenhagen is located along the Danish Inner Waters and upon the Baltic Sea, and it experiences relatively small tidal changes due to sea-level but there is a more significant alteration due to strong winds in the low-pressure storm systems that during winter traverse the Baltic Region, often generating storm surges and flooding.[487] These are only parts of the consequences impacting the City of Copenhagen which along with the other Scandinavian countries, decided to develop and enforce strong legislation in adapting and mitigating the effects of the climate crisis. The City has placed public-private partnership at the core of its eco-innovative and sustainable approach to climate change. Indeed, the City works side by side with companies, organizations, universities to develop and implement green growth.[488] The City can also be considered a pioneer in the transportation sector, committing to shift into the world's most feasible city for cycling, with the goal of achieving CO_2 neutrality by 2025. These characteristics made it possible for the city to be conferred with the European Green Capital Award in 2014.[489] In the international arena, Denmark has a strong background in developing cooperation and engagement at the

[484] Ibid

[485] City of Stockholm, (2016), *op. cit.*, p.46

[486] Hallegatte, S., et al., (2010) Assessing climate change impacts, sea level rise and storm surge risk in port cities: a case study on Copenhagen, *Climate Change*, 104(1), p. 114

[487] Ivi, p. 115

[488] European Commission, (2014) 2014 – Copenhagen, [online] Available at: https://ec.europa.eu/environment/europeangreencapital/winning-cities/2014-copenhagen/

[489] Ibid

international and regional level. Indeed, Denmark was rated in the first place in the 2015 Commitment to Development Index, playing a leading role in the development of the Agenda 2030 and the SDGs.[490]

In this context, it is worth mentioning and exploring the UN17 Village Project in Copenhagen. The building project aspire at creating a sustainable district in which all 17 SDGs are incorporated in a sustainable blueprint of 35,000 square-meters.[491] The project is being developed in the southern suburb of the City, Ørestad, on the island of Amager by NREP in collaboration with Sweco Architects, Lendager, MOE and CG Jensen.[492] The design foresees the construction of five different buildings, employing ecological and recycled materials – from glass to wood – and following the ambitious goals of the Agenda 2030, integrated in one single project.[493] The UN17 Village is trying to prevent the inevitable loss that derives from urbanization processes, by embedding nature and biodiversity from the local Amager Fælled natural reserve through green recreational spaces, courtyards, green buildings and rooftops, which will function as carbon storage, as rainwater and heat buffers and will help improve the acoustic and the microclimatic conditions of the neighborhood. In addition, to further reduce building's overall carbon footprint, the (re)use of sustainable material is being promoted along with resource efficiency and circular economy.[494] The village will also be able to recycle 1.5 million liters of water each year thanks to rainwater collection facilities. The water will be treated and recirculated back, employed in household uses, in irrigation systems directed to the green areas, greenhouses and gardens. For water heating, geothermal energy and roof-solar panels will be installed, as the buildings are conceived to curb consumption of energy while also recycling it.[495] Moreover, the district will also have public spaces for residents and the persons of Ørestad, and a conference center, health centers, organic restaurants, greenhouses and food-growing facilities are also being developed in the area.[496]

The UN17 Village represent a genuine and sustainable hub, where the most important challenges depicted in the 17 SDGs are being incorporated not only in a modern urban project,

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[490] Halonen, M., et al., (2017) *Sustainable Development Action – the Nordic Way: Implementation of the Global 2030 Agenda for Sustainable Development in Nordic Cooperation*, Nordic Council of Ministers, pp. 16-17, Available at: http://norden.diva-portal.org/smash/get/diva2:1092868/FULLTEXT01.pdf

[491] United Nations Environment Programme, (2019) *The sky's the limit as architects design UN17 eco-village in Copenhagen*, UNEP, [online] Available at: https://www.unep.org/news-and-stories/story/skys-limit-architects-design-un17-eco-village-copenhagen

[492] Sweko Denmark (n.d.) *UN17 Village*. [online] Available at: https://www.sweco.dk/showroom/un17-village/

[493] UN17 Village. (n.d.). *UN17*. [online] Available at: https://www.un17village.dk/en/village

[494] Ibid

[495] United Nations Environment Programme, (2019) *op. cit.*

[496] Ibid

but in the lifestyle of its residents, making the Ørestad district and Copenhagen, a landmark of sustainability and health, setting the example for future ecological developments. The local administration developed in 2012 a strategy to address major flooding due to increased precipitation patterns, the Cloudburst Management Plan.[497] The plan will be addressing pluvial flood hazard through adaptive measures that store or drain water in excess at ground level, for instance by reopening streams, constructing new canals, lakes and more green spaces, and using roads with high curbstones to funnel pluvial flood water. More specifically, the Cloudburst Management Plan counts four surface and pipe-based solutions, including the following: stormwater roads and tubes transporting water towards harbors; detention roads for water storage; detention areas able to store large volume of water and green roads to retain water in smaller side streets.[498]

Certainly, challenges and hindrances were in the way, such as the development of the project on private lands and streets. Nonetheless, it contributed to the creation of numerous job positions, the appreciation of land, the upgrading of urban areas and neighborhoods.[499] What is more, thanks to the Cloudburst Management, the city of Copenhagen was awarded with the Eurocities Award 2021, for enhancing and planning fresh urban spaces, other than an efficient water-management network to prevent the sewage and drainage system to collapse under pluvial flooding and storm surge.[500] An original initiative advanced by the Municipality is the "Greenkayak", using them to collect garbage. By doing so, urban citizens and visitors have jointly collected more than 24 tons of waste from harbour waters since 2017, spreading a sense of belonging and responsibility across the City and its community.[501]

By now, it is well established that urban centers represent the place where most of greenhouse gases are emitted and where the impacts of climate change are felt more than ever. Urban buildings, houses, parking lots, and infrastructures are more in general accountable for great amounts of CO_2 emissions. In addition, the building materials employed for their

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[497] Climate-ADAPT, (n.d.) *The economics of managing heavy rains and stormwater in Copenhagen – The Cloudburst Management Plan — Climate-ADAPT.* [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/the-economics-of-managing-heavy-rains-and-stormwater-in-copenhagen-2013-the-cloudburst-management-plan

[498] Ibid

[499] Ibid

[500] Eurocities, (2021) *Top city prizes at Eurocities Awards 2021*, [online] Available at: https://eurocities.eu/latest/top-city-prizes-at-eurocities-awards-2021/

[501] City of Copenhagen, (2014) *Copenhagen European Green Capital 2014 — five-year report*, p. 15. Available at: https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2020/Copenhagen_5-year_report.pdf

construction absorb solar radiations and heat, thus heavily contributing to the urban heat-island effect. Copenhagen, with other cities as Cape Town, Johannesburg, Paris, and Vancouver, signed the Net Zero Carbon Buildings Declaration, committing to foster regulations and interventions to net zero carbon buildings, setting a series of sustainable materials and standards to be followed to reach zero-impacts constructions, in line with the goals of the Paris Agreement.[502] In this context, the mayors of Copenhagen, Oslo and Stockholm announced the effort to reduce GHG emissions from construction sites and civil works, with the purpose of curbing air pollution by CO_2 emissions, improving social and health benefits.[503]

In Copenhagen, the CPH 2025 Climate Plan calls for actions to rein in emissions by 2025, following and strengthening the path that led Copenhagen to cut its emissions by 38 percent since 2005.[504] The Plan stresses the importance of cooperating with experts in the field, with regional and international stakeholders, with the business and civil community, living the city day-by-day, following the objective of becoming the first carbon free capital.[505] Another important aspect for the City of Copenhagen is expanding green areas, enhancing biodiversity and the reproduction of natural ecosystems in the urban arena. Therefore, the Municipality signed the Urban Nature Declaration, engaging in developing green jobs, mapping climate vulnerability and risk, making nature a public comprehensive goal.[506] In the C40 framework, the City of Copenhagen is engaged and in cooperation with a substantial number of networks, namely, the Municipal Building Efficiency Network, the Clean Energy Network, the Walking and Cycling Network, and the Connecting Delta Cities Network. The latter is guided by the City of Rotterdam and includes coastal delta cities collaborating to address the sea-level rise, coastal and pluvial flooding as well as water management and it will be covered in detail in the next chapter. [507]

The City of Copenhagen, together with the case studies of Malmö and Stockholm, are considered leading examples where the main challenges imposed by climate change are turned

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[502] C40 Cities, (n.d.) *Net Zero Carbon Buildings Declaration*, [online] Available at: https://www.c40.org/declarations/net-zero-carbon-buildings-declaration/

[503] C40 Cities, (2019) *Mayors of Copenhagen, Oslo and Stockholm commit to clean construction*, [online] Available at: https://www.c40.org/news/mayors-of-copenhagen-oslo-and-stockholm-commit-to-clean-construction/

[504] City of Copenhagen, (2016) *CHP 2021 Climate Plan: Roadmap 2017-2020*, p. 6. Available at: https://kk.sites.itera.dk/apps/kk_pub2/index.asp?mode=detalje&id=1586

[505] Ibid

[506] C40 Cities, (n.d.) *Urban Nature Declaration*, [online] Available at: https://www.c40.org/declarations/urban-nature-declaration/.

[507] C40 Cities. (n.d.). *Connecting Delta Cities Network*. [online] Available at: https://www.c40.org/networks/connecting-delta-cities-network/

into opportunities to transform and improve the urban environment. They are attempting at achieving climate-neutrality municipalities by following sustainable principles, by incorporating nature as an integral part of the city and its infrastructures. The road ahead is still crowded with many kinds of obstacles, and major changes still need to be implemented, starting with people's mindset and attitude. But the examples set by Scandinavian cities, their solid networks and initiatives certainly represent the right path.

3. Climate action throughout the Euro-Mediterranean macro-region: making Mediterranean cities resilient to climate change

The Mediterranean Region, touching the continents of Africa, Asia and Europe, is characterized by unique cultural heritages, significant history and heterogeneity of ecosystems. Yet, the basin is also source of constant changes, characterized by multiple anthropogenic activities, urbanization patterns, industrial development, other than being one of the busiest maritime hubs.[508] A key feature of the Mediterranean climate is hot and dry summers, and it is being increasingly characterized by the effects of climate change, in particular by more rapid warming and heatwaves.[509] Consequently, there is wide evidence of decreased summer precipitations patterns, resulting in water scarcity and insecurity – especially in the driest regions of Africa and Asia – prolonged periods of droughts, wildfires, and influence in human activities, from agriculture to livestock and fishing. Moreover, the Region is subject to unequal distribution of resources, social and political instabilities, regional conflicts and intense migration flows.[510] The interaction of these challenges along with invasive climate hazards generates situations of strong precariousness, sometimes forcing people to escape from serious violations of their fundamental rights, directly deriving from political unrests and from climate change impacts. Suffice is to say that the intensity and frequency of extreme weather events forces the displacement of over 20 million people every year.[511]

Rife evidence report that rise in sea-levels will also interest the Mediterranean basin. There are no certainties when it comes to predicting the average sea-level rise and these doubts will

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[508] Cramer, W., Guiot, J., and Marini, K., (2019) R*isk associated to climate and environmental changes in the Mediterranean Region*, MedEC, p. 5.

[509] United Nations Environment Programme, Mediterranean Action Plan and Plan Bleu (2020) *State of the Environment and Development in the Mediterranean*, Nairobi, p. 62. Available at: https://planbleu.org/wp-content/uploads/2021/04/SoED_full-report.pdf

[510] Cramer, W., Guiot, J., and Marini, K., *op. cit*., p. 5

[511] United Nations Refugee Agency (2018). *Climate Change and Disasters*. [online] UNHCR. Available at: https://www.unhcr.org/climate-change-and-disasters.html

largely influence the Mediterranean Sea level rise, due to the connection to the global Ocean via the Strait of Gibraltar.[512] Concerning water availability and security, this will decrease as a consequence of falls in precipitations, temperature increases and demographic growth, especially in countries more in need of water supplies.[513] River flows and lake levels will endure significant changes as well. For instance, Lake Beyşehir in Turkey, the largest freshwater lake in the Mediterranean Region and the first source of crop-irrigation, is expected to dry out by 2040 if significant action to tackle climate change is not adopted.[514] Environmental changes have also acute impacts on food provisions. Urbanization and migration patterns, along with transformation of diets, will lead to larger demand for food supplies, crops, fishing and livestock yields are expected to decrease in many areas as a result of climatic and other stress factors.[515] Fisheries and aquaculture are significant sources of food and economy for the Region and yet, they are impacted by intense overfishing and overexploitation, ocean acidification, and rise in sea's mean temperature, also causing the alteration of marine life.

These effects also lead to modification in species composition and abundance. Generally, cold-water species become less widespread or even extinct while warm-water species increase, leading to homogenization of the Mediterranean biodiversity.[516] The Mediterranean land ecosystem is impacted by direct consequence of global warming, but also by changes in land use, extensive human activities, urbanization, unsustainable tourism, provoking land fragmentation.[517] An important role of land ecosystems, forests and wildlife in general are natural carbon sink, meaning that they absorb more carbon than they release.[518] Lastly, the coastal composition is directly affected by erosion due to sea level rise, extreme weather events, salt trespassing into coastal groundwater and degradation of natural habitats.[519]

Considerable studies and pieces of evidence suggest that climate change together with alterations in land-use, pollution, atmospheric concentration of CO_2 and species transformations, has already affected living organisms, populations and communities, terrestrial

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[512] Cramer, W., Guiot, J., and Marini, K., *op. cit*., p. 8
[513] Ivi, p. 10
[514] Bucak, T., et al., (2017) Future water availability in the largest freshwater Mediterranean lake is at great risk as evidenced from simulations with the SWAT model, *Science of the Total Environment*, 581-582 (2017), p. 413
[515] Cramer, W., et al., (2018) Climate change and interconnected risk to sustainable development in the Mediterranean, *Nature climate change*, Vol. 8, p. 975
[516] Cramer, W., Guiot, J., and Marini, K., *op. cit*., pp. 12, 15
[517] Peñuelas, J., et al., (2017) Impacts of Global Change on Mediterranean Forests and Their Services, *Forests*, 8(12), p. 1
[518] Cramer, W., Guiot, J., and Marini, K., *op. cit*., p. 13
[519] Ivi, p. 17

and marine ecosystems in the Mediterranean area, and will do so in the future.[520] Hence, to avoid and limit further shocks to the natural and urban environment, prompt action must be taken in a holistic manner, involving regional and international organizations, the civil society, national governments and urban administrations. The Mediterranean Region is characterized by numerous regional and urban networks, joining forces to address environmental changes in cities, most of whom are characterized by less resources and possibilities to tackle climate hazards, notably in the southern part of the Region. Such initiatives are decisive in building a culture and an attitude towards cooperation and reinforcement in cities' capacities to manage similar problems, by interchanging, sharing and transferring technical expertise, knowledge and experience, even though facing the challenge deriving from dependency on project funding and investment.[521]

There are varieties of network initiatives, from formal well-managed partnership of cities to informal systems of cities or networking platforms with ad hoc membership. It also comprehends organization with exclusive membership from Mediterranean municipalities, international associations with a regional Mediterranean focus that include the contribution of Mediterranean cities.[522] Many of these organizations were born as a consequence of the Barcelona Process, which in 1995 was launched with the intention of consolidating such relations between Europe and the countries in the Southern Mediterranean. The desire and willingness to cooperate eventually led to the creation of the Union for the Mediterranean (UfM) in 2008.[523] In 1991, MedCities was established in Barcelona when 16 cities joined forces to support environmental protection from a local standpoint. In 2015, the network became a wholly independent union now gathering 63 local administrations from all shorelines of the Mediterranean basin.[524] In 1999 the Forum of Adriatic and Ionian Cities was established under the proposal of the Municipality of Ancona and the Italian National Association of Municipalities (ANCI), gathering approximately 60 cities from the 7 nations of the Adriatic-Ionian Basin while the Euromed was set up in 2000 to foster the cooperation between local authorities and Euro-Mediterranean partnership.[525] The Network of Associations of Local

[520] Peñuelas, J., et al., *op. cit.*, p. 22
[521] United Nations Environment Programme, Mediterranean Action Plan and Plan Bleu, *op. cit.*, p. 186
[522] Ibid
[523] Union for the Mediterranean (UfM), (n.d.) *25 Years of the Barcelona Process*. [online] Available at: https://ufmsecretariat.org/25bcnprocess/#:~:text=The%20Barcelona%20Process%20was%20launched%20in%201995%20with
[524] MedCities, (n.d.). *About us - MEDCITIES*. [online] Available at: https://medcities.org/about-us/
[525] United Nations Environment Programme, Mediterranean Action Plan and Plan Bleu, *op. cit.*, p. 186

Authorities of South-East Europe (NALAS) came to life in 2001 after the first Forum of Cities and Regions of South-East Europe, it was organized by the Congress of Local and Regional Authorities of the Council of Europe and brings together 14 associations representing roughly 9000 local authorities.[526] The Euro-Mediterranean Regional and Local Assembly (ARLEM) draws together local and regional representatives from the EU and its Mediterranean partners, established in 2010 by the European Committee of the Regions (CoR).[527] Likewise, Mediterranean cities participate actively in some international and European networks, such as those focused on environmental issues, the Covenant of Mayors and Mayors Adapt, C40 cities, and 100 Resilient Cities among the others.[528]

At the Regional level, many initiatives and declarations launched at the regional and international level aimed at supporting collaboration between countries on a series of common goals. In 1975 the Mediterranean Action Plan (MAP) was established as a multilateral environmental agreement in the setting of the United Nations Environment Programme (UNEP) and its Regional Seas Programme, to foster cooperation in tackling the common challenges of marine environmental deterioration.[529] Also, the INTERREG V B MED Programme 2014-2020 wants to promote sustainable growth in the Mediterranean area by encouraging innovative practices (new technologies, governance, ground-breaking services), promoting the sustainable use of natural and cultural resources, spurring low-carbon and energy-efficient approaches.[530] One of the plans funded by the MED in the period 2014-2020 was the project CO-EVOLVE, with the purpose of assessing and promoting the co-evolution of human actions and natural habitats in touristic coastal areas, facing climate change effects and encouraging sustainable development of touristic activities, coexisting with other coastal and marine reserves and ecosystems.[531] At the adaptation level, during the 19th meeting of Contracting Parties (COP19) of the Barcelona Convention[532] approved in 2016 the "Regional Climate Change Adaptation

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[526] NALAS, available at: http://www.nalas.eu/AboutUs

[527] United Nations Environment Programme, Mediterranean Action Plan and Plan Bleu, *op. cit.*, p. 186

[528] Ivi, p. 187

[529] United Nations Environment Programme (n.d.). *UNEPMAP*. [online] Available at: https://www.unep.org/unepmap/

[530] Climate-ADAPT (n.d.) *Mediterranean Area* [online] Available at: https://climate-adapt.eea.europa.eu/countries-regions/transnational-regions/mediterranean

[531] Ibid. To learn more on the project: https://co-evolve.interreg-med.eu

[532] The Barcelona Convention refers to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean was adopted in 1995 replacing the 1975's Mediterranean Action Plan established by 16 Mediterranean Countries and the European Community. https://ec.europa.eu/environment/marine/international-cooperation/regional-sea-conventions/barcelona-convention/index_en.htm

Framework for the Mediterranean Marine and Coastal Areas", with the idea of building a shared regional strategic approach to boost climate resilience and adaptation capacity.[533] In 2019 during the COP21 Barcelona Convention, the Naples Ministerial Declaration emphasized the necessity for a systematic transition underpinned by progressive and innovative approaches, policies, and behaviors.[534]

The Mediterranean Basin hosts a variety of cultures and countries, embracing three different continents and rich natural ecosystems. Pushed by the urgency of halting extreme weather events and to create e a strong political cooperation between such different countries, there are now plenty of initiatives, organizations, NGOs, regional and local networks moving towards the common goal of reaching peace and security and guaranteeing a healthy environment and green transition. Case studies of European cities in the Mediterranean adapting to climate change will be shown in the following paragraphs.

3.1 Adjusting Spanish and Portuguese municipalities to a changing climate

Spain, being the second largest country in the European Union, is part of the Iberian Peninsula, along with Portugal. Spain has a notable climatic diversity, spanning from humid Atlantic conditions to vast semi-arid areas, with intense hydrological impacts, and also cold alpine climates in some remote points of the Peninsula.[535] Indeed, Spain contains four of the nine biogeographical zone characterizing the European Union, namely Atlantic, Alpine, Mediterranean and Macaronesian climate, symbol of a great environmental composition, a very differentiate flora and fauna communities and the existence of a wide variety of ecological niches.[536] This climatic heterogeneity is the result of Spain's latitudinal position on the northern edge of the subtropics' belt, its compound mountain chains, its peninsular nature, and the two surrounding bodies of water, the Atlantic Ocean and the Mediterranean Sea, resulting in extreme events such as droughts, heat waves, sea-level rise and severe rainfall and floods.[537]

The effects of climate change are already widespread and visible, impacting communities, urban areas and natural habitats and the Mediterranean coastline, exposing them to great risks. These scenarios are raging from the expansion of semi-arid climate and drought periods, the

[533] Climate-ADAPT (n.d.) *Mediterranean Area.*
[534] United Nations Environment Programme, (n.d.) *Who we are – UNEMAP* [online] Available at: https://www.unep.org/unepmap/node/7619
[535] Climate-ADAPT (n.d.) *Spain — Climate-ADAPT.* [online] Available at: https://climate-adapt.eea.europa.eu/countries-regions/countries/spain
[536] Ibid
[537] Ibid

prolongation of wintertime (nearby five weeks more if compared to the 1980s), more heatwaves events and the heating of the Mediterranean Sea surface, approximately of 0,34 °C every decade.[538] Therefore, National agencies, local authorities, formal and informal networks, the civil society is attempting to develop efficient strategies to cope with the most invasive impacts of environmental changes, from mitigation to adaptation measures. For instance, the *Plan Nacional de Adaptación al Cambio Climático* (PNACC) 2021 – 2030 proposes to give shape to the increasing adapting demands across Spain and to their international arrangements, paving the way to a more resilient development to climate change in the upcoming decades, to shape a more inclusive and safer environment.[539] The overall objective of PNACC 2021-2030 is to promote joint action against the impacts of climate change in Spain, with the intention of avoiding or reducing current and future hazards and losses and building a more resilient economy and society.[540] Amongst its main objectives, the reinforcement of climate patterns assessment and risk assessment, the strengthening of adaptation policies in national and local public policies, and inclusion of all stakeholders, including the different levels of government, the private sector, social organizations and the public as a whole, to vigorously contribute to the advancement of responses to the hazards arising from climate change.[541]

At the local level, the City of Barcelona proposes several initiatives to cope with the most invasive climate impacts it is experiencing, i.e., decreased precipitations, heat waves and as a consequence the heat-island effect. The Barcelona Green infrastructure and Biodiversity Plan 2020 (BGIBP) lays out the challenges, objectives and commitments of the local administration for preserving green infrastructures and biological diversity and determining how people can discover their natural heritage, benefitting and developing with it.[542] The Plan has the purpose of setting out long-run actions to achieve green infrastructures and areas, which in turn will create benefits for city dwellers, providing environmental protection, reconnecting the city with its natural heritage.[543] In harmony with the BGIBP, the Barcelona's Tree Master Plan for 2017-2037 sets out a number of activities and initiatives to enlarge tree coverage while enhancing

[538] Ministerio para la Transición Ecológica y el Reto Demográfico (MITECO), (2020) *Plan Nacional de Adaptación al cambio climático 2021-2030*, p. 8. Available at: https://www.miteco.gob.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/pnacc-2021-2030_tcm30-512163.pdf

[539] Ivi, p. 11

[540] Ivi, p. 47

[541] Ibid

[542] Medi Ambient i Serveis Urbans - Hàbitat Urbà and Ajuntament de Barcelona (ed.) (2013) *Barcelona Green Infrastructure and Biodiversity Plan 2020*, p. 9. Available at: https://ajuntament.barcelona.cat/ecologiaurbana/sites/default/files/Barcelona%20green%20infrastructure%20and%20biodiversity%20plan%202020.pdf

[543] Ivi, p. 10

the climate resilience of the urban trees.[544] Indeed, Barcelona wants to turn into a comprehensive model of urban sustainability and therefore has committed in planting trees and fostering green areas as climate buffers. In fact, city trees offer a series of benefits: absorbing air pollutants, storing carbon, softening noise pollution, regulating humidity and balancing the water cycle, generating habitats for urban biodiversity other than an enjoyable urban landscape.[545] To better fit the City's environmental situation, efforts include the selection of more heat and water resilient tree species, diversification of tree species, employ of runoff water for irrigation and control of water leaking. Several research stressed the relatively small amount of green space per inhabitant in Barcelona. Yet, it has more road trees than most European municipalities and its action is improving the city with great green areas.[546]

Another original illustration is given by Terrassa, in the Region of Catalonia, which boasts a herd of over 700 sheep and plans to open a vineyard, vast stretches of forest, with 40 square kilometers of greenbelt embracing the city, creating green spaces and a places for recreational and economic activities for its residents.[547] The idea to preserve a green ring (*Anella Verda* in Catalan) around the city is rooted in the well-supported *Declaració per a la qualitat del paisatge i dels espais naturals i agraris de l'Anella Verda de Terrassa*[548] that backed the necessity to reverse the deterioration of natural and agricultural land in the town, to reduce the environmental impact and to incorporate the full management of the area's ecological, economic and social resources.[549] Indeed, nowadays the Terrassa *Anella Verda* represents a valuable resource for its citizens, managing the sustainable development of the city and its peripheral area.

In addition, a network of pathways and spaces further attempt to ensure that the area can be used properly in order to limit the environmental impacts, for instance by spreading and raising awareness in local schools, through workshops and initiatives and excursions to get acquainted with the local flora and fauna.[550] Also, agriculture and breeding, timber industries all use the soil of the green ring. Hence, Terrassa is also dedicated to the rehabilitation of its local products

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[544] European Environment Agency, (2018) *10 case studies. How Europe is adapting to climate change*, Luxembourg, Publications Office of the European Union. Available at: https://climate-adapt.eea.europa.eu/about/climate-adapt-10-case-studies-online.pdf

[545] Ibid

[546] Ibid

[547] Godson, A., (2021) *Terrassa's Green Ring*. Eurocities [online] Available at: https://eurocities.eu/stories/terrassas-green-ring/

[548] Anella Verda de Terrassa (n.d.). *Procés de participació ciutadana*. [online] Available at: https://anellaverda.terrassa.cat/proces-de-participacio-ciutadana/

[549] Godson, A., (2021) *Terrassa's Green Ring*

[550] Ibid

and the local brand the Terrassa Gastronomic strive to push gastronomic tourism.[551] Lastly, the *Anella Verda* is home to a significant amount of biological diversity and wildlife, surrounding the urban area of Terrassa, where sustainability has come to be a significant asset in multiple aspects of its dwellers and its territory.

In the southern part of the Iberic Peninsula, the City of Sevilla is the beating heart of Andalusia with its cultural and historical background, being an important hub of touristic, economic and political activities. These aspects are strictly connected to the City's climate. During summer, temperatures frequently exceeded 50ºC, and predictions announce a further increase in the average temperature of 4.5ºC and a reduction in rainfall of 20 percent. This hostile scenario has inevitable impacts on the health of city dwellers, the economic development, employment, and urban planning.[552] The project CartujaQanat is taking place in la Isla de la Cartuja, in the river Guadalquivir. The Area became an exhibition for inventive technology in bioclimatic architecture and temperature control solutions during the 1992 Global Exposition, hosting now the University and the Cartuja Technology Park coexist in this space, grouping public entities, companies, university students and other activities. Yet, public recreational spaces with good conditions are lacking, particularly in summer.[553]

The project wants to represent a revitalization operation of the urban area developing a new paradigm of public-private governance and creating a sustainable carbon-free and energy-efficient district.[554] The project represents a horizontal program led by the municipal administration and the *Empresa Metropolitana de Abastecimiento y Saneamiento de Aguas de Sevilla*, addressing the strategic priorities under the Sevilla 2030 Strategic Plan, ensuring habitable outdoor spaces, adopting energy-efficient ways to shield the heat-island effect, and reinvigorating urban common spaces by strengthening new stakeholders and partnerships.[555] Cooling off a public space with zero energy consumption represents one of the ambitions of the project. In this framework, new and innovative techniques are being tested, such as developing traditional ceramic as a colling material, representing a traditional and historical industry in the City. Indeed, they are attempting to both identify new methods of ceramic usages – as a

[551] Ibid
[552] Urban Innovative Actions (2021). *CartujaQanat - Recovering the street life in a climate changing world*. [online] Available at: https://www.uia-initiative.eu/en/uia-cities/sevillav
[553] Ibid
[554] Ibid
[555] Karyd, K., (ed.) (2021) *CartujaQanat – Recovering the street life in a climate changing world*. [online] Available at: https://www.uia-initiative.eu/en/news/cartujaqanat-recovering-street-life-climate-changing-world-journal-2-how-sevilla-moving-needle

temperature cooling down agent – and providing new production opportunities.[556] The CartujaQanat clearly represents one of the many attempts of the City to transform its areas into climate resilient zones, where the well-being of citizens and of future generations are put into first place. Last but not least, it is worth mentioning the Brick-Beach Project in the coastline of Vélez-Málaga, in Andalusia, facing the Moroccan coasts. The city is increasingly facing coastal erosion due to sea-level rises, extreme weather events and waves which, other than the constant loss of sand, bring new sediments, reaching the sea also through the rivers.[557]

As a consequence, the waste currently accumulates in unauthorized landfills. Soil, stones, asphalt pavements, bricks, glass, plastics, and timbers are piled up on protected and natural areas, affecting the environment and the territory.[558] The innovative solution proposed by the Brick-Beach project use the materials from landfill sites for the recreation of the littoral area, producing a high-quality recycled aggregate material suited as a beach material through a debris treatment plant, to regenerate impaired sandy beaches such as the Mezquitilla.[559] The project, after several political obstacles, slowdowns arising from the Covid-19 pandemic, and public protests, the pertinent authorities have finally issued a positive environmental authorization with regard to the recycling plant, which is about to be ready for further implementation.[560] However, the project continues to be in a critical position due to other environmental authorizations still pending, to which tenders must be added, and awareness raising on the projects – through networking and public talks – were postponed or canceled due to Covid-19 restrictions.[561] Despite obstacles being in the way, much is expected from this project, starting from a regenerated urban area and a healthy coastal landscape, creating more recreational green areas, economic development and job opportunities.

The case studies explained in the paragraph attempt to frame the importance of nature in the Spanish territory, given by the climatic and environmental biodiversity that characterize the Peninsula. Also, in the last years, Spain is emerging as a leader in the climate agenda, being the host of the 25th Conference of the Parties held in Madrid in 2019, the last one before the outbreak of the pandemic crisis, showing its increasing involvement in the subject. Certainly, more timing actions are required to cope with decreased precipitations, sea-level rise and the

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[556] Ibid
[557] Urban Innovative Actions (2021). *BRICK-BEACH - Artificial regeneration of urban beaches with eroded recylced aggregates*. [online] Available at: https://www.uia-initiative.eu/en/uia-cities/velez-malaga
[558] Ibid
[559] Lucena, M., (2021) *The Brick-Beach Project*, Urban Innovative Actions, N° 5, p. 2
[560] Ivi, p. 7
[561] Ivi, p. 19

dry and hot climate that interest most of its cities. Yet, the majority of Iberian towns are showing promptness, involvement and decision in their urban environmental actions, despite the difficulties they may encounter.

As part of the Iberian Peninsula, Portugal has a moderate mediterranean climate whose influence is particularly felt in summertime, climatic influences coming from the Peninsula's continental mass, causing a decrease in mean rainfall and an increase in average temperatures.[562] Furthermore, climate change predictions estimate that the number of days with extreme heat will increase, with urban areas being more vulnerable, and with the intensification of urbanization processes, the problem of heat-related mortality will likely increase.[563] At the national level, stressing the importance of reintroducing nature in urban areas, the *Associação Nacional de Coberturas Verdes* (ANCV - Portuguese National Association of Green Roofs) is a national NGO established in 2015, with the purpose of promoting green infrastructures and nature-based solutions in cities, notably those that can be directly installed in new or pre-existing buildings - such as green roofs and walls.[564]

The ANCV's action, at national and international levels, focuses on four areas of action in which, specific work and partnerships are developed with business stakeholders, municipalities, research and development institutions, and international community, to integrate and foster green, biodiverse and resilient urban territories.[565] For instance, *Praça de Lisboa* is Porto's largest green roof area, representing an example of a nature-based solution where a number of SDGs of the United Nations' 2030 Agenda are being adopted (good health and well-being, sustainable cities and communities, climate action).[566] In addition, in 2016 the ANCV concluded a pioneer initiative, the *Porto Fifth Façade*, in association with the Porto City Council. The project wants to define the best practices and patterns that the City should adopt to implement green infrastructures in the urban environment.[567] In 2014, the City adopted a local environmental strategy to tackle the most pressuring challenges, organized around five

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[562] Climate-ADAPT (n.d.). *Portugal* [online] Available at: https://climate-adapt.eea.europa.eu/countries-regions/countries/portugal

[563] Climate-ADAPT (n.d.) *Operation of the Portuguese Contingency Heatwaves Plan* [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/operation-of-the-portuguese-contingency-heatwaves-plan

[564] Pineda-Martos, R., and Calheiros, C. S. C., (2021) Nature-Based Solutions in Cities—Contribution of the Portuguese National Association of Green Roofs to Urban Circularity, *Circular Economy and Sustainability*, Issue 3, p. 1027

[565] Ibid

[566] Atanasova, N., et al. (2021) Nature-Based Solutions and Circularity in Cities, *Circular Economy and Sustainability*, Issue 1.

[567] Palha, P., et al., (2017) *A new GI policy for the city of Porto, Portugal,* ANCV.

axes designed to guide the energetic transition, move towards a circular economy and the use of nature-based solutions.[568] In this context, Porto considers itself a city empowering innovations in multiple areas through the participation of pilot projects and the involvement of its citizens and their ideas. Indeed, the Municipality funded and supported several projects led by its dwellers and has joined the CitiMeasure, an EU-backed initiatives involving other major cities and following the experience of the Dutch City Deal, with the purpose to elaborate, design and verify citizens measurement solutions.[569]

The City of Porto and its initiatives underlines the importance of city networking, the sharing of experience and knowledge across cities and most of all, the inclusion, in the development of urban actions, of citizens and the civil society drawing upon their personal experiences of living the city. Porto is the second largest Portuguese city after the Capital, Lisbon which like many other coastal areas, is likely to face the impacts of climate change, in particular a reduction in annual rainfall and an intensification in frequency and duration of drought periods, and an estimated increase in minimum and maximum temperatures.[570] For this reason, the Municipality developed a program monitoring water leakage, WONE, to better manage sources of water in periods of strong drought, through a comparison of expected water usage data to actual and real-time water usage.[571] The City of Lisbon is also protagonist of the EU-launched project Sharing Cities, involving as well the cities of Milan and London and respectively the zone of *Porta Romana/Vattabbia* and the Royal Borough of Greenwich, will develop urban smart and digital solutions by renewing buildings, proposing shared electric mobility services, planting systems of power management, smart lamp spots and an urban sharing platform to engage directly with citizens.[572] In the case of Lisbon, the project covered the downtown area of the city including the main historical and touristic districts, with a hundred thousand inhabitants.[573] The strategy's main goals are to attract more peoples by improving housing quality, implementing energy-efficient transports, offering smart living services and

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[568] Dragonetti, W., (2022) *Porto believes in citizen science to strengthen its environmental strategy* [online]. Available at: https://eurocities.eu/latest/porto-believes-in-citizen-science-to-strengthen-its-environmental-strategy/

[569] Ibid

[570] Climate-ADAPT, (2021) *Private investment in a leakage monitoring program to cope with water scarcity in Lisbon*. [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/private-investment-in-a-leakage-monitoring-program-to-cope-with-water-scarcity-in-lisbon/#challenges_anchor

[571] Ibid

[572] European Commission (n.d.). *Sharing Cities*, Smart Cities Marketplace. [online] Available at: https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects/sharing-cities

[573] European Commission, (n.d.) *Sharing Cities Site Lisbon*, Smart City Marketplace. [online] Available at: https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects/sharing-cities/sharing-cities-site-lisbon

opportunities that will spur the economy and boost employment, social cohesion and involvement, attracting more entrepreneurs and widening access to higher education.[574] More concretely, amongst the measures adopted there are the retrofitting of buildings to render them more efficient, improve street lights with 64,000 smart lampposts, introduce platforms to achieve powerful e-vehicles charging stations, establish traffic controlling systems and an open data platform to guarantee transparency and the engagement of city dwellers.[575]

According to the C40's City profile, Lisbon is engaged in numerous regional and international environmental networks and initiatives, to better address the problematic deriving from the changing climate. For instance, the Private Building Efficiency network (to cope with the heavy amount of CO_2 emissions deriving from buildings and infrastructures), the Clean Energy Network, the Zero Emission Vehicles (ZEV) Network, the Land Use Planning and Urban Flooding Networks (to avoid incorrect land uses and improve flooding management) the Cool Cities Network and many others.[576] Lastly, the City of Braga, called the "Portuguese Rome" due to its origin in the Roman city of Bracara Augusta and for being strictly linked to its ancient roman legacy,[577] has developed the Human Power Hub the city's new center for social innovation aiming at boosting social entrepreneurship and cohesion.[578] The project gave life to numerous social businesses, for example, the BeCoffee uses coffee leftovers to make composite materials as sustainable substitution of plastic and reduce the carbon footprint of the city.[579] Also, the City developed the Living Lab for Decarbonization, where new procedures for the production and storage of clean energy will be formulated and studied in a real-life scenario, for instance inside a creative arts edifice dedicated to human activities and interactions.[580]

In Portugal, a characteristic feature of its cities are the historical buildings and habitations, defining municipalities such as Braga, Guimaraes, Lisbon, Porto, exemplifying the cultural heritage that Portugal has to offer on one side and a hindrance for green transition towards climate resilience on the other. Yet, the cities are actively engaging in urban initiatives, supported by the European Union, and also at the national and local level, to balance the

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[574] Ibid
[575] Ibid
[576] C40 Cities. (n.d.) *Lisbon.* [online] Available at: https://www.c40.org/cities/lisbon/
[577] Eurocities (n.d.) *Braga*. [online] Available at: https://eurocities.eu/cities/braga/
[578] Godson, A., (2020) *Citizens make the city*. Eurocities [online] Available at: https://eurocities.eu/stories/citizens-make-the-city/
[579] Ibid
[580] Berretta, D., (2021) *Cities, power plants of the future*. [online] Available at: https://eurocities.eu/stories/cities-power-plants-of-the-future/

historical and cultural inheritance with a fair green transition to create a healthy and equal environment for its peoples and its ecosystems.

3.2 Strategia Nazionale di Adattamento ai Cambiamenti Climatici - SNAC: climate policies and projects in Italian cities

The Italian Peninsula is an interesting and peculiar case study for regional climate patterns, due to its complex topography and the atmospheric influences of the North African arid climate and the Central European temperate and rainy climate.[581] Indeed, the climate change impacts in Italy are causing the increase in average temperatures, the incidence of extreme weather events – heatwaves, heavy rains, landslides and coastal flooding – the deterioration of air quality, the risks of wildfires aggravated by droughts.[582] In the summer of 2020, severe fires hit central-southern Italian regions and cities, for instance Pescara in Abruzzo, destroying part of its beaches and the Natural Reserve Pineta Dannunziana, Reggio Calabria and Cosenza in Calabria, urban and rural areas in Apulia, Sicily and Sardinia, forcing them to declare a state of emergency. The characteristic of the Italian atmospheric influences makes the local climate subject to numerous variations. For instance, in the mountain areas precipitations are generally abundant – snow and rain – and the climate is cooler if compared to coastal zones, affected by more continental variations, while territories nearby lakes may have a milder climate, generating a variety of microclimates characterizing the whole Peninsula.[583]

The Italian Constitution does not have specific provisions on the protection of the environment, due to the social and historical period in which the Constitution was drafted – right after the Second World War - and due to the limited urbanization and industrialization of the Country, other than the prevalence of the agricultural industry.[584] With the amendment of the Title V of the Italian Constitutional Charter, after the constitutional law n. 3/2001, the notion of "environment" appears in the Constitutional Charter, even if limited to art. 117, specifically dedicated to the shared legislative competences between the central State and the Regions.[585]

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[581] Spano, D., et al., (2020) *Analisi del rischio. I cambiamenti climatici in Italia*, Centro Euro-Mediterranea sui Cambiamenti Climatici, p. 17. [online] DOI: 10.25424/CMCC/ANALISI_DEL_RISCHIO

[582] World Wildlife Fund Italia, (2021) *2021 effetto clima: l'anno nero dell'agricoltura italiana*, Ottobre 2021, p. 6. [online] Available at: https://www.wwf.it/cosa-facciamo/pubblicazioni/clima-lanno-nero-dellagricoltura-italiana/

[583] Ivi, p. 11

[584] Lugaresi, N., *op. cit.*, p. 59

[585] Ibid

A turning point in the Italian environmental law occurred when law n. 308/2004 was adopted, with which the Parliament delegated the Government to reorganize, coordinate and incorporate environmental legislation in internal policies and regulations. From here, the legislative decree n. 152/2006, entitled *Norme in materia ambientale* which became effective in April 2006.[586] However, the Decree 152/2006 encountered several obstacles along the way, from contrasts with the European Union legislation to political contrasts related to the shifts of the Government majority shortly after its adoption.[587] Yet, the decree produced the *Testo Unico per l'Ambiente,* which transposed EU Directive 2004/35/CE, through which took place the regulation of the multiple aspects concerning environmental matters.[588] Its purpose, defined in Article 1, is to "establish a framework of environmental liability based on the 'polluter-pays' principle, to prevent and remedy environmental damage."[589]

To be in accordance with European actions in environmental matters, Italy has established the *Strategia Nazionale per lo Sviluppo Sostenibile* (SNSvS), following these main principles enlisted in the UN Agenda 2030, integration, universality, transformation and inclusion.[590] The SNSvS represents the national framework for the planning, the design and the evaluation of environmental assessment, in accordance with art. 34 of Legislative Decree no. 152/2006, according to which, the Ministry supports the Regions, Autonomous Provinces and Metropolitan Cities in the territorial development of the SNSvS.[591] The legal basis for the SNSvS is given from the Italian Resolution n. 108/2017 on the approval of the *Strategia nazionale per lo sviluppo sostenibile*.[592] Taking in consideration the adaptation strategy to tackle climate change, it can be stated that Italy is taking many steps forward in this direction. Also, noteworthy is the *Piano Nazionale di Ripresa e Resilienza* (PNRR), developed and adopted in the framework of the EU-funded NextGenerationEU.[593] More Generally, the

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[586] Ivi, p. 61

[587] Ibid

[588] Franceschelli, F., *op. cit.*, p. 106

[589] European Parliament and the Council Directive n. 2004/35/CE on *environmental liability with regard to the prevention and remedying of environmental damage* (21 April 2004), Official Journal L 143/56. [online] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32004L0035&qid=1644066513236

[590] Ministero della Transizione Ecologia, (2022) *Strategia Nazionale per lo Sviluppo Sostenibile* [online] Available at: https://www.mite.gov.it/pagina/strategia-nazionale-lo-sviluppo-sostenibile

[591] Ibid

[592] Delibera n. 108/2017 sull' *Approvazione della strategia nazionale per lo sviluppo sostenibile* (22 dicembre 2017), [online] Available at: https://ricerca-delibere.programmazioneeconomica.gov.it/media/docs/2017/E170108.pdf

[593] Lenzi, S., (A cura di) (2021) *Report Urban Nature 2021 Verso Città "Nature Positive" Decementifichiamo il nostro territorio. Rinverdiamo la nostra vita*, p. 17. [online] Available at: https://www.wwf.it/cosa-facciamo/pubblicazioni/verso-citta-nature-positive-report-urban-nature-2021/

NextGenerationEU is an EU Recovery Plan expanding a series of prompt and targeted actions in a series of framework, for instance, the green and digital transition, in health, in assuring social human rights, going against racism and xenophobia.[594] The PNRR develop the following core missions: the digitalization process, the green revolution and ecological transition, sustainable mobility and infrastructures, research and education, inclusion and social cohesion, and finally, health provisions.[595]

Following the European Union Adaptation Strategy of 2013, at the national level the *Strategia Nazionale di Adattamento* (SNAC) was approved in 2015, yet, with non-binding provisions.[596] Its main objective is to develop a national view on the common path that needs to be adopted to tackle climate change, by counteracting and mitigating its impacts.[597] In this regard, SNAC shall identify actions and guidelines to reduce the risks arising from climate change, safeguard health, the well-being and assets of the population, preserve the natural heritage, improve resilience and adaptability of natural, social and economic systems.[598]

Italy has also developed the SNAC following the valuable and consolidated principles developed by other European countries in their national strategies. In particular lessons have been drawn from the experiences and experiments of Belgium, Denmark, Finland, France, Germany, United Kingdom, Spain, Switzerland.[599]

The strategy is committing in adopting an environmental approach based on knowledge and awareness, especially when it comes to involving international stakeholders and citizens, following the key aspect of research and development and the complementary aspect of mitigation and adaptation. For instance, there is strong synergy between the adaptation and mitigation actions concerning agriculture, forestry, energy and water resources, infrastructures and transportation.[600] An example of this interaction is to consider a mitigation action that increases the natural role of carbon sink that forests possess, promoting reforestation in both natural and urban areas; to consider an adaptation measure that reduce the flooding vulnerability by promoting functional basins, including healthy forests and natural spaces – an example of

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[594] European Union, (n.d.) *NextGenerationEU; Make it Real*. [online] Available at: https://europa.eu/next-generation-eu/index_en _

[595] Ministero dell'Economia e delle Finanze. (n.d.). *Il Piano Nazionale di Ripresa e Resilienza (PNRR)*. [online] Available at: https://www.mef.gov.it/focus/Il-Piano-Nazionale-di-Ripresa-e-Resilienza-PNRR/

[596] Franceschelli, F., *op. cit*., p. 322

[597] Ministero della Transizione Ecologia (2015) *Strategia Nazionale di Adattamento ai Cambiamenti Climatici,* p. 10 [online] Available at: https://climate-adapt.eea.europa.eu/countries-regions/countries/italy

[598] Ibid

[599] Ivi, p. 11

[600] Ivi, p. 12, 74

this would be the role the coral reefs and mangroves play in buffering storm surges.[601] The cooperation and interaction between adaptation and mitigation measures are essential, having the possibility to jointly counteract and prevent environmental hazards, in addition to granting a resilient and ecological transition of modern societies and countries. The SNAC follows the precautionary principle pertaining to situations of scientific misgivings and also follows the principles of environmental sustainability and intergenerational fairness, meaning that any form of climate adaptation must not compromise the interests and well-being of future generations, nor must it undermine the capacity of other natural and socio-economic systems to contribute to adaptation.[602]

The National Strategy covers numerous areas of interests, going from the relationship between the environment and human health, extremely important given the current pandemic situation, forests and coastal areas, the agricultural and fishing industry, the transportation and energy sector, urban infrastructures, the tourism industry and the national cultural heritage, and so forth. Moreover, special attention is given to risk assessment, management and reduction, in order to develop efficient adaptation actions. At the local and urban level, the Strategy stresses the serious threat to which cities are exposed to. Indeed, being mainly man-made systems, their resilience must be ensured almost entirely by anthropogenic interventions, representing an unprecedented challenge for national and local governments and requiring combined short-term and long-run interventions.[603] Given the diverse environmental impacts that Italian cities are expected to endure – heatwaves, heavy precipitations, flooding, landslide - it can be concluded that the costs of adaptation interventions will certainly be lower than the ones of inaction, especially considering some adaptation actions are cost-free or minimal and others consist in the distribution of costs already supported for urban management - water and sewerage, urban green areas, maintenance of infrastructures.[604] The SNAC took inspiration from both international and European environmental regulations, and national rulings as well, starting from the Legislative Decree n. 190/2010 on a National Strategy for Biodiversity which in turn, applies the Council and the European Parliament Directive 2008/56/CE of 17 June 2008 establishing a framework for community action in the field of marine environmental policy.[605]

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[601] Ibid

[602] Ivi, p. 13

[603] Ivi, p. 49

[604] Ivi, p. 50

[605] Franceschelli, F., *op. cit.*, p. 322-323. EU Directive 2008/56/EC available at: https://eur-lex.europa.eu/eli/dir/2008/56/oj#:~:text=Directive%202008%2F56%2FEC%20of%20the%20European%20Parliament%20and%20of,of%2017%20June%202008%20establishing%20a%20framework%20

More recently, in 2016 the *Piano Nazionale di Adattamento ai Cambiamenti Climatici* (PNACC), still in a developmental stage and non-binding as the SNAC, was set up with the purpose of providing an up-to-date framework of current national environmental trends and future climate scenarios by identifying priority actions, monitoring and assessment tools to supervise the sectors settled in the SNAC.[606] According to the Institutional text, the PNACC aims at implementing the National Strategy by updating and developing its core contents, familiarize with the national adaptation framework and making it fully operational for the draft of adaptation actions at different governmental levels and in different spheres of intervention.[607]

It is important to mention that Italy has been very active and involved in both European and international climate negotiations, conventions and initiatives. Indeed Italy, with other EU member states, ratified the Kyoto Protocol in 2002 through Law n. 120/2002, committing to reduce its emissions by 6.5 percent compared to 1990 levels in the period 2008-2012, a goal that all EU countries successfully achieved.[608] Also, Italy was fully committed during the Paris Agreement negotiation process together with the European Union, and pushing to allow the best possible implementation of the agreement, overcoming the limitations of the Kyoto Protocol, and pressuring for a transparent and equal system of governance.[609]

Last year, Italy was amongst the protagonists of the international environmental agenda, hosting in July 2021 the G20 on Environment, Climate and Energy in Naples. Under the Italian Presidency, two days of intense debate between ministers, diplomats, delegations took place to discuss ecosystem-based approaches and nature-based solutions, using these as models and means to tackle climate change, biodiversity and poverty; the protection and restoration of degraded soils; sustainable water management and the reinforcement of sea protection; limiting the marine plastic pollution; encourage cooperation for the sustainable and circular use of resources; and lastly, the role of central governments in supporting cities.[610] The Official document drafted in the G20 sessions reiterates the need to build a better future in line with the SDGs of the Agenda 2030 by protecting, conserving and if necessary, restoring natural

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[606] Ibid

[607] Ministero della Transizione Ecologica, (2018) *Piano Nazionale di Adattamento ai Cambiamenti Climatici*, pp. 7-8. [online] Available at: https://www.mite.gov.it/pagina/piano-nazionale-di-adattamento-ai-cambiamenti-climatici

[608] Ministero della Transizione Ecologica (2019) *Cambiamenti climatici: UNFCCC e Accordo di Parigi* [online] Available at: https://www.mite.gov.it/pagina/cambiamenti-climatici-unfccc-e-accordo-di-parigi

[609] Ministero della Transizione Ecologica (2016) *L'Italia alla COP21* [online] Available at: https://www.mite.gov.it/pagina/litalia-alla-cop-21

[610] Ministero della Transizione Ecologica (2022) *G20Energia, Clima e Ambiente – Napoli 22/23 Luglio 2021.* [online] Available at: https://www.mite.gov.it/pagina/g20-energia-clima-e-ambiente-napoli-22-23-luglio-2021

ecosystems, preventing loss of habitats and biodiversity, accelerating the transition towards "inclusive, sustainable and just low-carbon economies" making communities more resilient to the impacts of climate hazards and lastly ensuring that "biodiversity loss, land degradation and climate change will be addressed together as part of broader environmentally sustainable and inclusive recovery plans and actions in the post COVID framework." [611]

In addition, Italy hosted in September 2021 in Milan the last official ministerial meeting, the PreCop, before the COP26 held in Glasgow in the same year, under the British Presidency in partnership with Italy. The UK and Italy pledged to place climate change and the reversal of biodiversity loss at the core of the environmental multilateral agenda in 2021, including through the UK G7, Italian G20 and COP26 Presidencies.[612] During the summit in Naples, the energy transition and climate sustainability working groups in the Joint G20 Energy-Climate Ministerial Communiqué, placed an emphasis on resilient and sustainable cities, acknowledging the weight of national governments in promoting local and sub-national initiatives, recognizing the crucial role that cities play in pursuing internal climate policies, highlight the role of cities, and large metropolitan areas as strategic partners for a sustainable and inclusive expansion, to accelerate the pace of a neat and sustainable energy transition, in accordance with the goals established by the Paris Agreement and taking into account the current pandemic crisis.[613] The role of bottom-up initiatives - Global Covenant of Mayors, the C40 and ICLEI – are crucial in this fight and in assisting cities, together with other state's initiatives to create leading carbon-free communities, to facilitate international city-level cooperation, to encourage public private partnerships, to foster the implementation of NbS or EbA within and around cities, and finally to support the direct involvement of all relevant non-state actors, "including Indigenous People, local communities, academia, women, youth and underrepresented communities."[614]

At this point, it is widely established that the cities are the controversial places where 70 percent of GHG are more intense, where the main cultural, economic and financial interactions

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[611] G20, (2021) *G20 Environment Communiqué*. Preamble, point 5, p. 2. [online] Available at: https://www.mite.gov.it/sites/default/files/archivio_immagini/G20_Napoli_2021/2021_07_22_ITG20_ENV_Final.pdf

[612] UN Climate Change Conference (COP26) (n.d.). *The UK-Italy Partership*. [online] Available at: https://ukcop26.org/pre-cop/

[613] Energy Transition and Climate Sustainability Working Groups, (2021) *Joint G20 Energy-Climate Ministerial Communiqué* (23 July 2021), Par. 5, points 49-50, p. 11. [online] Available at: https://www.mite.gov.it/sites/default/files/2021_G20%20Energy-Climate%20joint%20Ministerial%20Communiqué.pdf

[614] Ivi, Par. 5, points 49, 51, pp. 11-12.

take place, where the effects of climate change are widespread and lastly, it is particularly in cities that pandemics such as the Covid-19 still in progress can smoothly spread.[615] Therefore, the cities are the hub where a fair and green transition are taking place, to create resilient centers adapted to the impacts of climate change. Indeed, urban territories tend to prefer and implement nature-based solutions, for instance a strategy involving blue and green infrastructures (roofs and walls), as these proved to be effective and natural buffers against extreme climate events, improving the quality of air, enriching the soil with organic waste, contributing to the production of quality local food, improving the physical and mental health of residents and enhancing the urban landscape.[616] Hamburg's green roofs, Chinese sponge-cities, urban farms in European cities, Singapore's Gardens by the bay, and Miami's mangroves, the *Bosco Verticale* in Milan are just a few of the many models showing the interaction between urban areas and natural ecosystems. In the City of Milan, the CLEVER Cities (Co-designing Locally tailored Ecological solutions for Value added, socially inclusivE Regeneration in Cities) is an EU-funded Project developed in the context of the European Horizon 2020 Programme, also taking place in cities such as Belgrade, Malmö, Madrid, London, Quito.[617] Hamburg, London and Milan are the leading cities in the Project, experimenting and adopting NbS in neighborhoods crucial for urban regeneration, supporting the CLEVER Action Labs (CAL) - in which residents and institutional, professional, economic and entrepreneurial actors are involved - and coordinating the implementation of actions with a long-term view on sustainability.[618]

CLEVER Cities Milan is starting with three green infrastructures and a creative nature-based solutions experimentation in the southern belt of the City, intending to expand them throughout the city.[619] First, a new park for Giambellino 129 is being developed within the neighborhood, including green buffer areas close to the railway, a water management and monitoring mechanisms and accessible sensors that encourage use by dwellers with the aim is of stimulating shared use of public spaces.[620] Moreover the park, - after a drainage intervention – will host a nature reserve for bird-watching, a wild meadow and reserve for butterfly; a

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[615] Lenzi, S., (edited by) *op. cit*., p. 7.
[616] Ibid
[617] WWF Italia (edited by) (2020) *Safe cities in armonia con la natura: per città più verdi, più sane, più sicure,* p. 14 [online] Available at: https://www.wwf.it/cosa-facciamo/pubblicazioni/safe-cities-in-armonia-con-la-natura/ To learn more on the project: https://clevercities.eu/the-project/
[618] Ibid
[619] CLEVER Cities (n.d.). *CleverCities - Milan*. [online] Available at: https://clevercities.eu/milan/
[620] Ibid

vegetable garden and an orchard for the community; various plant species, green walls and roofs.[621] Secondly, the plan to re-design the railway Tibaldi station, by introducing green areas and other NbS with the intention of improving the management of rainwater runoff; contribute to the CO_2 storage; will involve travelers and citizens in the co-management of common green areas also by offering them pleasant and healthy common areas.[622] Lastly, the "Rinverdiamo Milano", re-greening process of the City aims at spreading the development of green roofs and walls on buildings throughout Milan, in partnership with new and existent stakeholders, launching sessions to spread awareness, sharing good practices, elaborating pilot projects and monitoring systems reflecting the environmental and social benefits of the initiatives.[623]

In the Italian scene, one of the most innovative and creative initiatives, embodying the concept of nature-based solutions is the Vertical Forest, in the Milanese district of Isola, which is a residential complex carried out by Italian Architect Stefano Boeri. The project consists in two towers housing a total of 800 trees, around 15,000 perennials and 5000 shrubs, supplying an amount of vegetation corresponding to approximately 30,000 square-meters of wood and undergrowth concentrating around 3000 square-meters of urban surface.[624]

Fig 3 - Vertical Forest in Milan (from: Stefano Boeri Architetti)

[621] WWF Italia (edited by) (2020), *op. cit.*, p. 16
[622] Ivi, p. 17
[623] CLEVER Cities, *op. cit.*
[624] Boeri, S. (2018). *Vertical Forest,* Stefano Boeri Architetti. [online] Stefano Boeri Architetti. Available at: https://www.stefanoboeriarchitetti.net/en/project/vertical-forest/. To learn more on the projects based on the Vertical Forest model: https://www.stefanoboeriarchitetti.net/en/projects/

As a consequence, the Vertical Forests embrace the principles of NbS by regulating and reducing humidity, releasing oxygen and absorbing CO_2 and microparticles, lastly creating a comfortable internal microclimate without detrimental effects on the environment, shielding sun rays instead of attracting and storing them, as happens with glass or stone-based facades.[625] In addition, a few years after its edification, the Vertical Forest has generated a habitat where numerous animal species have settled, including nearly 1,600 specimens of birds and butterflies, establishing a colony of natural flora and fauna recolonization in the city. "The variations in color and shapes of the plants produce a tremendous iridescent landmark in every season and it is highly recognizable even at a distance."[626] It is undeniable that the Vertical Forest has drawn international attention for its architectural and environmental innovations, representing a pioneering action in urban environmental sustainability, exporting this model abroad, with projects in Eindhoven, Utrecht, Treviso, Huanggang, Cairo an many others.

By putting the City of Milan in the spotlight, the Vertical Forest symbolizes the notion of nature-based solutions, representing a powerful and valuable tool in the fight against climate change. Following the pattern of ecosystem-based solutions and following the steps of Boeri's design, the project of the *Nido Verticale* is developed by Architect Mario Cucinella, the building in the Porta Vittoria district is about to become the headquarters of the UnipolSai insurance group.[627] The materials employed are mainly wood, metal and glass and in the interior, curved pillars made of wood will meet forming a vertical nest with a rhomboidal texture on the walls, giving the name to the whole complex.[628] The structure of the building is characterized by a double layer amid which there will be a hollow isolating the edifice from the winter cold and preventing excessive heatwaves and the heat-island effect, solar panels installed at strategic points, rainwater collection systems, the building's energetic consumption is reduced to a minimum, and lastly, plants and trees will be placed on the roof, creating a fully sustainable tower just steps away from the Vertical Forest.[629]

An important aspect for Italian cities is the relationship between its urban territories and rural areas, a reality that is strongly rooted in the Italian landscape, strictly connected to agriculture and the food industry. Urban-rural relationships are essential to the enhancement of nutrition and therefore the security of people, as it facilitates the availability of top-quality food at

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[625] Ibid
[626] Ibid
[627] Garofalo, F., (2016) *Nido Verticale, la nuova torre sostenibile di UnipolSai a Milano*, Lifegate [online] Available at: https://www.lifegate.it/nido-verticale-torre-unipolsai-milano
[628] Ibid
[629] Ibid

reasonable prices, especially if we take into consideration the crucial role that the culinary culture and the food sector has in Italy.[630] Based on the events of recent years, especially during the health crisis, have helped increase the presence of CSA, Community-Supported Agriculture, to deliver healthy and organic food for the community, following the principles of reciprocity and solidarity, recovering and re-adjusting abandoned and damaged land, and including the protection of soil and biodiversity.[631] In Italy, the CSA Cresco (Valvaraita, Cuneo) is one of the latest to arrive, while between 2020 and 2021, at least four others were launched in Trento, Modena, Turin and Ravenna.[632] Also, worth mentioning is the *Parco delle Risaie - Un cuore agricolo per la Città di Milano*, which has been working on a 650 hectares-urban-agricultural area close to Milan, more precisely between the *Naviglio Grande* and the *Naviglio Pavese*.[633] The rural rice fields are the protagonists of the project. This territory is subject to strong anthropogenic pressures that need to be safeguarded through interventions that improve its accessibility, to guarantee the qualification of the environmental landscape and a competitive agriculture within the Milanese urban system.[634] Also, after Expo 2015 "Feeding the Planet, Energy for Life" taking place in Milan, the City has implemented its food policy, the Milan Food Policy, which is to date, the most accepted Italian Food Policy both at the European and international level.[635]

Mazzocchi et al. provide us with the case of the *Casal del Marmo* Park area, in the northern Rome, an agricultural area immersed in the urban fabric of the City, with the ability to provide multiple benefits from food supply, regulation of ecosystem services, to delivery of cultural services, having direct and indirect impacts on the well-being of the urban population.[636] Rome, the capital of Italy and one of the most singular cities in the world, is severely exposed to extreme heatwaves and acute air and noise pollution, and is attempting to adapt and develop smart and green solutions. For instance, the Citizen Wallet is a platform that encourages the sustainable behavior and choices of city dwellers, aimed at improving the environmental, social

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630 Lenzi, S., (edited by) *op. cit*., p. 47

631 Altreconomia. (2021) *Le nuove Csa nate nella pandemia per un'agricoltura di relazione*. [online] Available at: https://altreconomia.it/le-nuove-csa-nate-nella-pandemia-per-unagricoltura-di-relazione/

632 Ibid

633 Lenzi, S., (edited by) *op. cit*., p. 51

634 Ibid

635 WWF Italia (edited by) (2020) *op cit.*, p. 44

636 Mazzocchi, G., et al., (n.d.) *Ecosystem Services Multi-level assessment for integrated governance approach: the case of the Casal del Marmo Agricultural Park area in Rome* (Italy), ics. In WWF Italia (edited by) (2020) *Safe cities in armonia con la natura: per città più verdi, più sane, più sicure*, p. 39 [online] Available at: https://www.wwf.it/cosa-facciamo/pubblicazioni/safe-cities-in-armonia-con-la-natura/

and economic sustainability of the city, in line with the objectives of the 2030 Agenda.[637] Concerning the transportation systems, Rome's subway network is still being enlarged and improved. Thus, new electric buses, trams, trolleybuses car and bike-sharing, and cycling paths are increasing to compensate for the deficiency of a large subway infrastructure, becoming an integral part of the city's sustainable mobility renovation that in recent years has been assisting the Capital to align with EU environmental goals.[638] Additionally, the City's ambition is to widen the electric means to comprise hydrogen and supercapacitor buses, which can be recharged some 100,000 times during their lifetime compared to batteries' 7,000; and when it comes to their disposal, every component of a supercapacitor can be recycled and put to other uses (for instance, carbon fibers can be used as bike components).[639] Director of *Roma Servizi per la Mobilità* Stefano Brinchi is very determined in developing hydrogen and supercapacitor means of transportation, affirming that "We've had a preliminary performance assessment and results are excellent."[640]

The case samples presented above of depicted the initiatives that are being adopted in the first two largest Italian cities – Milan and Rome. Yet, there are numerous and more contained urban realities that are moving in the right direction when it comes to the ecological and resilient transition of cities. Despite representing a big reality, Turin, capital of the heavy industry and headquarter of the Fiat Automobiles, is often described as a grey and dreary city. Yet, the city features over 50 square meters of green place per resident, and its inhabitants can expect to arrive at a green recreational space within 300 meters of their home.[641] The City has an impressive heritage of green infrastructures, composed of rivers, parks, hills and vegetable gardens shaping the identity of the city and its quality of life; in particular, it enjoys a widespread and diversified urban green system, capable of producing a variety of ecosystem services that provide prominent benefits for the community.[642] The City boasts a green area system of over 48,000,000 squared-meters (public and private) representing about 37 percent of the municipal area, in line with the standards of European cities, (about 55 squared-meters

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[637] Città di Roma (n.d.) *Dettaglio progetto Smart Citizenship*. [online] Available at: https://www.comune.roma.it/eventi/it/roma-innovation-smart-citizenship-dettaglio.page?contentId=PRG18880

[638] Berretta, D., (2022) *Rome's green mobility makeover* [online] Available at: https://eurocities.eu/stories/romes-green-mobility-makeover/

[639] Ibid

[640] Ibid

[641] Eurocities (2021) *Grey to green: a city adapting to crisis* [online] Available at: https://eurocities.eu/latest/grey-to-green-a-city-adapting-to-crisis/

[642] Città di Torino (2020a) *Piano di Resilienza Climatica*, Luglio 2020, p. 42 [online] Available at: https://www.torinovivibile.it/wp-content/uploads/2021/06/PianoResilienzaClimatica_TORINO.pdf

per inhabitant).[643] It has a wide variety of urban parks and historical gardens (the Parco del Valentino, I Giardini Reali, Giardini Cavour), parks on the city's hills (Parco della Rimembranza and Parco della Maddalena), river parks, outside the central urban area, cycle routes and links along roads and within the urban and peri-urban park system, urban allotments.[644] Indeed, it is not surprising that the city was amongst the finalists for the 2022 European Green Capital Award, which was eventually won by the City of Grenoble, France.

In the context of climate changes, the City is particularly exposed to heat waves and floods - due to the presence of the four water courses crossing the city, Dora Riparia Sangone, Stura di Lanzo, and Po. In 1994, 2000 and in 2016 the city suffered significant damage due to severe flooding and in 2003 declared the first emergency related to heat waves, a phenomenon intensifying in recent years and causing acute social and economic losses.[645] An important step in this pathway is the Plan of adaptation to climate change, in turn represented by the pilot of the Project Life DERRIS (Disaster Risk Reduction Insurance), which led to the preparation of the IDAP - Integrated District Adaptation Plan - related to the pilot area *Torino che protegge*, with the purpose increasing the resilience to environmental hazards of small and medium-sized enterprises (SMEs), which deeply suffer from the impacts of increasingly intense climate events, also because SMEs do not possess the adequate tools for assessing and managing these phenomena.[646] The project carried out a series of actions, for instance training and inspections in the companies to transfer assessment and management risk skills, tools to minimize the damages at the level of individual enterprises (such as the business adaptation plans), and after a period of testing and assessment in Turin companies, the model would spread throughout Italian enterprises.[647]

The City is widely engaged in regional and international networks of cities. In this respect, Turin has always been particularly active in the fight against climate change, joining in 2009 the European Commission's Covenant of Mayors, approving its *Piano d'Azione per l'Energia Sostenibile* (TAPE - Turin Action Plan for Energy) in September 2010, setting the ambitious target of reducing CO_2 emissions, reaching a reduction of 30 percent in 2020 compared to 1991's emissions levels; in 2015, the City acceded the Mayors Adapt while in 2019 signed the Global Covenant of Mayors for Climate & Energy, engaged in launching effective adaptation

[643] Città di Torino (2020b) *Piano Strategico dell'Infrastruttura Verde*, Dicembre 2020, p. 15 [online] Available at: https://www.torinovivibile.it/wp-content/uploads/2021/04/piano_strategico_infrastuttura_verde_2021.pdf
[644] Ibid
[645] Città di Torino, (2020a) *op. cit*., p. 18
[646] Ivi, p. 23
[647] Ibid

and mitigation campaigns.[648] Also, thanks to the technical and economic support of the German Marshall Fund of the United States, Torino Climate Lab was launched, creating networks and collaborations with the American cities of Portland (Oregon), Oakland (California) and New Orleans (Louisiana), which has made it possible to observe and learn from positive patterns of participatory processes, to verify the impacts of adaptation measures already implemented, even if in different territorial contexts than the Turin's one.[649] It is clear that Turin, in the foothills of the Alps, is very active in fighting environmental impacts by creating regional and international networks, enlarging its green areas and its renewable transportation system – from its newest subway system, 207 kilometers of cycle paths, car and bike sharing. Also, the City is transparent in its path toward sustainability, having a website entirely dedicated to the living conditions and characteristics of the City, its sustainability indicators in a series of subject areas, namely climate change, water and waste management, food policies, sustainable mobility, air quality and green infrastructures.[650]

A brief section will also be dedicated to the City of Bologna, at the heath of Emilia-Romagna and the *Pianura Padana*. In the past few days, the City has declared that air pollution and smog levels are above the PM10 limits and therefore, emergency measures are in force from 5 February, even though the anti-smog plan is in force from 1 October 2021 to 30 April 2022, providing ordinary and emergency traffic restrictions and other measures to protect air quality.[651] In the last decades, the City has undergone an intense industrialization and urbanization process, and the presence of firms, with service providers and houses, has negative impacts on road conditions, on the quality of life, causing polluting emissions that reach emergency levels for long periods of time.[652] The City is also hit by the hazards of the changing climate the most frequent being intense precipitation patterns, causing flooding and landslides, heatwaves and the consequent urban heat cup, drought periods resulting in water scarcity.

Despite the challenges, Bologna represents one of the most livable and sustainable cities in the Italian scenario, involved in cities networks such as ICLEI and the Covenant of Mayors and in European climatic initiatives. For instance, it is part of the EU-funded project LIFE CLIVUT

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[648] Ivi, p. 11, 13
[649] Ivi, p. 25
[650] To learn more: https://www.torinovivibile.it
[651] Comune di Bologna (2022), [online] Available at: https://www.comune.bologna.it/avvisi/smog-misure-emergenza and https://www.comune.bologna.it/notizie/qualita-aria-2021-2022
[652] Zauli Sajani, S., et al., (2016) UHI in the Metropolitan Cluster of Bologna-Modena: Mitigation and Adaptation Strategies. In Musco, F., (ed.) *Counteracting Urban Heat Island Effects in a Global Climate Change Scenario,* Cham Springer International Publishing, p. 133

– Climate Value of Urban Trees, with the objective of encouraging the sharing of knowledge and methodologies to implement planning and management strategies of urban green ares, with the final aim of mitigating the effects of climate change.[653] In the framework of the European project LIFE, the Bologna Local Urban Environment Adaptation Plan for a Resilient City (BLUE AP) is developed to deliver an efficient and sustainable adaptation plan for a Resilient Bologna. The main goals of the BLUE AP are to create an information system integrating environmental and social data, capable of producing new information on environmental risks and the best strategies to address them; raising awareness of local authorities, socio-economic parties and citizens of the real risks related to climate change, encouraging them to adopt more eco-friendly behaviors; offering technical and training support to design and implement interventions outlined in the Plan, launching pilot actions on the territory of Bologna with the contribution of local companies and actors and lastly, sharing and communicating the results of the project, promoting its spread and the sharing of expertise.[654]

The BLUE AP seeks to concretely intervene to tackle climate-related hazards, for instance by increasing urban greening, protecting and fostering vast wooded green areas and urban agriculture; strengthening insulation and greening in public and private structures through green roofs and walls; improving the city's hydrogeological infrastructures and response.[655] For instance, Bologna was one of the first Italian cities to boost urban vegetable gardens to increase the value of underutilized green spaces, attaining nearly 30 hectares of horticultural surface, 16 hectares of which are municipal, and the Plan determines new potential points for developing a sustainable urban orchard model, beginning with two batches in the Savena and San Vitale areas.[656]

There are infinite cities in the Italian scenario involved in the fight against climate change and in the green transition toward resilient realities that nowadays is becoming imperative. Many more case samples can be cited and developed, for instance *Modena città che cambia*, Lighthouse - *Genova Città faro,* StrategicAncona2025 in the harbor city of Ancona, the *Piano Energetico Ambientale Comunale* in the Municipality of Perugia, and so forth. In addition, an increasing number of Italian Municipalities are joining regional and international networks of

[653] Comune di Bologna (2021) *Progetto europeo LIFE CLIVUT,* [online] Available at: https://www.comune.bologna.it/servizi-informazioni/progetto-europeo-clivut

[654] Comune di Bologna (2021) *Bologna città resiliente,* p. 7. [online] Available at: http://www.comune.bologna.it/media/files/blueap_lr_ita_eng.pdf

[655] Ivi, pp. 48-49

[656] Ivi, p. 44

cities to share best practices and expertise, to create long-lasting connections and to involve as many stakeholders as possible, to eventually guarantee a fair, smart and green transition.

CHAPTER 4. ENVIRONMENTAL CHANGES IN THE NETHERLANDS: DUTCH CITES RESPONSES TO GLOBAL WARMING

1. Integrated initiatives to tackle climate change in the Netherlands: an overview

The Netherlands, a small country in Western Europe bordering the North Sea, is characterized by a series of deltas and flood plains of the watercourses Scheldt, Meuse, Rhine, and Ems, surrounded by coastal barriers in the shape of barrier islands in the north, a vast (former) lagoon, tidal inlets, and coastal plains.[657] The Dutch coastline stretches for more than 400 kilometers, and can be partitioned into three distinct sides: a) the tidal inlets and estuaries in the south which is mainly controlled by open or closed barriers to regulate waterflows, b) the uninterrupted dunes of the Holland Coast and the c) Wadden Sea Area, featuring a series of barrier islands – parts of the Frisian Islands – in the north.[658] Because of these geophysical characteristics, for centuries the Country was impaired by floods and inundation from waterflows and seas, and therefore, today two-thirds of the territory lies below sea level.[659] Despite the obstacles, the Netherlands sought to adapt and counter these phenomena through poldering – a process that entails the gradual recovery of land, the building of dykes to restrain seawater, or draining marshlands through windmills, the latter representing a historical process employed in the country – to keep low-lying lands fit to live in and suitable for agricultural purposes.[660]

In 1953, a catastrophic flood struck the Netherlands causing the drowning of 1836 people, the destruction of 47,000 homes and 500 kilometers of dams, and lastly many hectares of fertile land were compromised by salt water, bringing damages that amounted to 10 percent of GDP.[661] To prevent such a disaster in the future, the first Delta Commission developed a master plan, formulating what turned to be known as the first Delta Programme, which incorporated the Delta Works, a thorough and emblematic set of water works and services, dikes and coastal protection plans to manage water-related situations and protect the country against flooding and storm surges.[662] However, the Country's "usual" water challenges, in spite of the adopted

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[657] VanKoningsveld M., et al., (2008) Living with Sea-Level Rise and Climate Chang: A Case Study of the Netherlands, *Journal of Coastal Research* 25(2), p 367

[658] Ibid

[659] Mao, D. et al., (2020) *The Delta Programme: The Dutch integrated approach to climate resilience*, Centre for Liveable Cities Singapore, p. 1

[660] Ibid

[661] Bloemen, P., Var Der Steen, M., & Van Der Wal, Z., (2019) Designing a century ahead: climate change adaptation in the Dutch Delta, *Policy and Society*, 38(1), p. 63

[662] Ibid

measures, have persisted and to a certain extent, intensified.[663] With the increase of global temperatures and CO_2 emissions, the Dutch have experienced in particular higher sea levels and watercourses, intensified precipitation and increasing flooding from fluvial systems, and in addition augmented erosion of the sand dunes, - serving as natural coastal protections - larger claim for spatial development, land subsidence (from 0.5 to 1.0 cm each year), recurring summer droughts, and salt intrusion, which have also contaminated freshwater supplies.[664]

The Netherlands is a decentralized unitary state and so has been water management implementation, since territorial decentralization concerns the provinces and municipalities, covering an extensive liability while functional administrative bodies (e.g., regional water authorities) are responsible for one or more specific duties.[665] Also, water management has been deemed as a joint responsibility of public authorities, government, public administrative institutions and the Delta Commissioner, representing a fundamental core of public activity, while private actors such as NGOs, and water enterprises have a vital role in numerous other activities - dredging, construction of dikes, pumping stations and wastewater treatment plants.[666] The 2011 Administrative Agreement on Water Affairs emphasizes the shared responsibilities to regularize the water system, whereas central government, provinces, regional water authorities and municipalities all have specific tasks and responsibilities in this policy field, though municipalities are more involved with general public works than with strictly water-related activities.[667] More specifically, the Dutch water governance is in accordance with EU obligation to deliver proper and qualified authorities and administrative arrangements for managing river basin; Dutch provinces are, with respect to the Dutch Constitution, the superintendent of regional water bodies; Municipal authorities' liabilities cover the collection and transport of urban wastewater and tasks concerning rainwater and groundwater management in urban areas.[668]

Given the complexity of climate change impacts and having to explain the essential functioning in the Netherlands, the Second Delta Programme was launched in 2007, renovating the purpose of integrating flood risk management, freshwater supply and spatial planning to finally attain long-lasting resilience against climate change while in 2012 the Delta Act was

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[663] Mao, D. et al., *op. cit*., p. 1
[664] Ibid
[665] OECD (2014) *Water Governance in the Netherlands: Fit for the Future?* OECD Studied on Water, OECD Publishing, p. 30. Available at: http://dx.doi.org/10.1787/9789264102637-en
[666] Ibid
[667] Ivi, p. 31
[668] Ivi, pp. 33-34

enacted by the Dutch Parliament determining clear political support and leadership roles and allocating funding with the establishment of the Delta Fund.[669] Nowadays, all the Programme's actions are financed by the Delta Fund - differing by the central government budget - and an average of €1.25 billion a year has been allocated for the Fund up to 2032.[670] In the framework of the Delta Programme, the Delta Plan on Spatial Development – one of the three main focuses of the Programme – has been launched, containing all the projects and measures that have the purpose to render the Netherlands water-resilient and climate-proof by 2050.[671] The Plan sets out how the municipalities, district water boards, provinces, and the central government are planning to accelerate and strengthen the spatial adaptation transaction, focusing on seven main ambition, starting from mapping vulnerabilities, risk dialogues and strategies, implementation agendas, linkage opportunities, promotion and facilitation, regulating and integrating, responding to calamities.[672]

In fact, the Delta Programme generally relies upon an approach of adaptive management to ensure continuous efficiency of long-term programs by linking short-run decisions to long-term climate change, and maintaining strategies amenable and prepared to adjust if the future scenario it is altered beyond irrevocable tipping-points, depending on a series of ingredients – global warming, demographic growth, land-use change and water demand.[673] In addition, a Monitoring, Analyzing, Acting model is employed, where the Programme ascertains whether plans are still achieving the expected goals and if previous provisions should be tailored on novel developments; thus, the Programme is based on a 2100-planning horizon while thrusting to ensure that the Country will be climate-proof and water-resilient by 2050.[674] In this context, it is important to be supported by an organized and a multi-layered system of governance, in order to better coordinate actions amongst the main stakeholders. Indeed, the Delta Programme model of governance – operating jointly with administrative authorities and engaging society – is pivotal in securing an unbiased process of strategy formulation, agency co-ordination, and mobilizing public trust and backing.[675] In this context, the role of the Delta Programme

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[669] Mao, D. et al., *op. cit*., p. 2

[670] Governments of the Netherlands (2014) *Delta Programme: flood safety, freshwater and spatial adaptation - Delta Programme,* [online] Available at: https://www.government.nl/topics/delta-programme/delta-programme-flood-safety-freshwater-and-spatial-adaptation

[671] Governments of the Netherlands (2020) *Delta Plan on Spatial Adaptation* [online] Available at: https://english.deltaprogramma.nl/three-topics/spatial-adaptation/delta-plan

[672] Ibid

[673] Mao, D. et al., *op. cit*., p. 2

[674] Ivi, pp. 2-3

[675] Ivi, p. 4

Commission is essential for the functioning of the Programme, having also the chance to work closely with multiple levels of stakeholders, for example ministries, provincial and municipal governments as well as regional water boards, NGOs, businesses, the residents that live and work in the Country: collaborating with such variety of stakeholders is one of the key features of the Delta Programme.[676] In addition, the processes at the core of the Delta Programme have been successfully employed in other countries, most notably the United States after the devastating Hurricane Sandy in 2012 and more specifically, in the San Francisco's Bay Area, through the Resilience by Design, triggered by the city's foresight to develop wider resilience against sea level rise and other long-term hazards, reflecting the adaptability of the Programme in multiple occasions and setting the example for countries in distress at the regional and international level.[677]

Another distinctive aspect of the Delta Programme is that it pushes for the development and implementation of Building with Nature (BwN) strategies, where natural ecosystems are used to meet the society's need for multifunctional infrastructures that combine adaptability and sustainability.[678] An example is given by the Room for the Rivers project and the Norwaard measures as one of its biggest strategies. In the 1990s, extreme increases in water levels resulted in many problems for the Country, and leading to the project Room for the River, adopted as the new point of departure for how to address high water levels in and around Dutch rivers.[679] The Project represents an attempt to embrace the Rhine, the Meuse, the Waal, and the IJssel rivers in one solution, abandoning the obsolete asphalt-artificial infrastructure that will eventually deteriorate over the years and instead, preferring the use of nature and working with forces like the wind, and water – by employing mills - and land to keep water forces under control.[680]

Some of the strategies adopted to implement the Room for the River – and still in use nowadays – are the relocation of dikes further inland making the floodplains broader; discharging overflow water through a high-water channel; removal of obstacles and lowering

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[676] Ivi, pp. 4-5
[677] Ivi, p. 7
[678] Ivi, p. 4
[679] Ministry of Infrastructure and Water Management (n.d.). *Room for the Rivers* [online] Available at: https://www.rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers.
See also:https://www.rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/flooded-noordwaard-a-unique-situation
[680] Huet, N., (2021) *Dykes, storm gates and sponge parks: How can cities prevent flooding?* [online] Available at: https://www.euronews.com/green/2021/07/19/dikes-storm-gates-and-sponge-parks-how-can-cities-prevent-flooding

the river bed by digging the ground.[681] Since 2015, the Noordwaard at Werkendam is "best" known as a high-water flood territory and the Noordwaard is one of the major measures of the Room for the Rivers program.[682] In this area, the dams rise to a climax of 2 meters above AOD (Amsterdam Ordnance Datum)[683] and if water further rise, it automatically flows into the polder thanks to the Room for River as the plan has been designed so that roads and buildings remain intact.[684] Another case of BwN solution to cope with climate hazards is the Sand Motor projects along the Delfland coast. The Sand Motor aims at creating a provisional space for recreational activities and nature expansion, as well as acquiring a comprehensive grasp of the behavior of the coastal system.[685] The intervention involved a wide amount of sand retrieved offshore and placed along the coast in a single operation forming a hook-shaped peninsula and through the use of natural processes the Sand Motor is a shield against sea level rise mitigating the impacts of storm surges and coastal flooding. After four years of monitoring, the first complete assessment of the functioning of this solution was published in 2016, marking its success in coastal protection and witnessing the creation of new habitat for local flora and fauna.[686]

Following the ambition of a climate-proof Country, the Delta Program approached a varied group of actors to develop a long-term adaptation blueprint, and also to present ground-breaking short-term measures to help realize and implement the plan. In this regard, the wide green dike was widely promoted by a local water board, with the involvement of experts and nature conservation organizations, to develop a BwN effective plan.[687] From winter to summer dikes, from sea dikes to waterline ones, resulting in 43 different types of dams and 9 distinct dike systems the Netherlands boasts amongst the most elaborate and diversified dikes network in the world.[688] In the particular case of green dikes, they have a sand center which is coated by a

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[681] Ministry of Infrastructure and Water Management (n.d.). *Measures in and around rivers*. [online] Available at: https://www.rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers

[682] Ministry of Infrastructure and Water Management (n.d.) *Flooded Nordwaard: "A unique situation"* [online] Available at: https://www.rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/flooded-noordwaard-a-unique-situation

[683] The Amsterdam Ordnance Datum (AOD) is a unit of measurement employed to assess sea-level developed in most of Europe.

[684] Ministry of Infrastructure and Water Management (n.d.) *Flooded Nordwaard: "A unique situation"*

[685] Climate-ADAPT (2021) *Sand Motor – building with nature solution to improve coastal protection along Delfland coast (the Netherlands)* [online] Available at: https://climate-adapt.eea.europa.eu/metadata/case-studies/sand-motor-2013-building-with-nature-solution-to-improve-coastal-protection-along-delfland-coast-the-netherlands

[686] Ibid

[687] Van Loon-Steensma, J. M., & Vellinga, P., (2019) How "wide green dikes" were reintroduced in The Netherlands: a case study of the uptake of an innovative measure in long-term strategic delta planning, *Journal of Environmental Planning and Management*, 62(9), p. 1525

[688] LOLA. (n.d.). *Dutch Dikes*. [online] Available at: https://lola.land/project/dutch-dikes/

layer of clay and grass at the peak, on the coastal side while the middle and lower portion on the seaward part is covered in asphalt, with a coating of stones or cement blocks protecting the tip of the dam.[689] Under ordinary conditions incoming waves are cushioned by the salt-marsh headland, while only during severe storm conditions, when the marshland is underwater due to increased water levels, do waves reach the dams and because of the capacity of the salt-marsh foreland to buffer against waves and floods and the smooth seaward slope reducing wave impacts, the grass-concealed clay layer is able to protect against overflows and sufficient to defend the dam against erosion during extreme conditions.[690,691]

On the other side, traditional dikes have been built and employed over the past one hundred years in the Netherlands, characterized by steeper seaward slope concealed by tarmac, concrete or stones to counter wave and tidal loads.[692] Yet, a green dike may be more robust than a conventional one, as for instance if the top asphalted layer of the landward slope is compromised by erosion due to water overflowing while the larger volume of a green dike would offer more residual strength also providing additional advantages, such as larger higher robustness in utmost climate conditions, more versatility for adaptation and improved nature, landscape and territorial values.[693] Indeed, a transition from a traditional dike to a natural green dike does seem to be a feasible climate adaptation alternative for those regions – in the Netherlands and above – that are particularly hit by coastal and river flooding, storm and tidal surges, coastal erosion, providing a wining solution aby bearing greater opportunities for safety and climate resilience.[694] In the Netherlands the most significant dikes are for example, the closed dam of Afsluitdijk, between North Holland and Friesland, the Boulevard Scheveningen representing both a recreational area for Dutch residents and a key flood defense structure, the Westfriese Omringdijk, a well-known thirteen-century dam in North Holland, the dike-in-dune Kustwerk Katwijk and lastly, the Schielands Zeedijk, representing one of the most important dams in the Country and since its construction, it has never been really breached – except when in 1574 was divided in sixteen pieces, still representing the main protection for over 3.5 million residents in South Holland.[695]

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[689] Van Loon-Steensma, J. M., & Schelfhout, H. A., (2017) Wide Green Dikes: A sustainable adaptation option with benefits for both nature and landscape values? *Land Use Policy*, vol. 63, p. 528
[690] Ivi, pp. 528-529
[691] Van Loon-Steensma, J. M., & Vellinga, P., *op. cit*., pp. 1527-1528
[692] Ivi, p. 1528
[693] Van Loon-Steensma, J. M., & Schelfhout, H. A., *op. cit*., pp. 534, 529
[694] Ivi, p. 538
[695] LOLA, (n.d.) *Story Map Journal* [online] Available at: https://www.arcgis.com/apps/MapJournal/index.html?appid=3ebd596e8e5a45619024faf40897356f§ion=9

What can be stressed from the present paragraph, is that the Netherlands – especially due to its decentralized structure – is deeply involved in developing plans and strategies aimied at reducing and avoiding water-related climate hazards, flooding, storm surges and so forth. Apart from the Delta Programme, the National Climate Adaptation Strategy 2016 (NAS) "Adapting with Ambition" sets out a comprehensive policy for addressing the effects of environmental change, the second one after the first 2007 NAS Make Space for Climate.[696] Moreover, in 2012, the Netherlands Court of Audit published a report stating that the Dutch climate adaptation policy did not properly tackle all aspects of environmental change, and that its overall coordination could be upgraded, since the Delta Programme addressed a vast portion of climate adaptation, but not all of its aspects.[697]

In 2013 the Netherlands Climate Agenda announced the development of a new NAS, as a direct response of the 2013 EU Adaptation Strategy, introducing new proposals in order to accelerate the progress of ongoing initiatives, and addressing the following specific effects: greater heat stress; energy, IT and transportation infrastructures; crop failures and the agricultural industry; shifting climate zones since some flora and fauna species would be incapable of migration or adaption; stronger health burdens and lastly, aggregate effects whereby a systems shortcoming in one sector or at one location triggers further difficulties elsewhere.[698,699] Besides, it is important to acknowledge that attention must also be paid to those climate effects expected to emerge until rather later in the century but which call for urgent action due to their severe impacts (for instance, failure of the electricity supply grid due to extreme weather, restriction of shipping, the disappearance of habitats and species).[700] At this point, it is well established that the best method to make a country climate-proof, is by involving local and provincial authorities, private sector companies and actors, water authorities, international actors and social organizations to contribute, similarly as it occurred with the Delta Programme and also in the case of the NAS.[701] In the case of the NAS 2016, the Government attempted to launch projects and programs by following precise steps, namely spreading awareness on the urgence of climate adaptation, encouraging the implementation of adaptation

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[696] European Commission Staff Working Document No 2018/460 accompanying the document Report from the Commission to the European Parliament and the Council, (12 November 2018), p. 478, SWD (2018) 460 final

[697] Ibid

[698] Ibid

[699] Ministry of Infrastructure and the Environment (2016) *Adapting with Ambition - National Climate Adaptation Strategy 2016 (NAS)*, December 2016, p. 3. Available at: https://klimaatadaptatienederland.nl/en/policy-programmes/nas/

[700] Ibid

[701] Ivi, p. 31

measures, expanding and exploiting exports in the field, addressing more pressing climate risks, incorporating climate adaptation within policy and legislation whilst monitoring the progress and effectiveness of strategies.[702] In order to accomplish these key purposes, an Implementation Programme (*Uitvoeringsprogramma Nationale klimaatadaptatiestrategie*, UP NAS) has been launched in 2018 identifying six priorities for the 2018–2019 period, (heat stress, infrastructures, agriculture, nature, built environment and collaborating on provincial and regional strategies) with the primary objective being raising awareness, involving more parties in the NAS implementation process more specifically the cooperation between government authorities, research institutes, the private sector and civil-society organizations that was settled when NAS 2016 was formulated.[703]

In order to accomplish a climate-resilient and a carbon-free Country by 2050, more resolute climate adaptation and mitigation actions are required, aside from expertise and widespread partnership. In this respect, the Climate-proof Together network was launched to strengthen the efforts and adaptation against climate hazards; City Deals fosters cooperation between cities, NGOs, the central government to promote and enhance the livability of Dutch cities; the Climate-proof cities develops and shares knowledge on best practices and measures to make cities climate-proof and water-resilient, as part of the National Water and Climate Knowledge and Innovation Programme (NKWK); The Global Center on Adaptation (GCA) attempted to foster global climate adaptation, encouraging countries, NGOs, organizations, enterprises to share knowledge and collaborate on climate adaptation, with its headquarter in a floating office in Rotterdam.[704] Other important initiatives to tackle the changing climate and to protect the environment are proposed and launched by the National Institute of Public Health and the Environment (RIVM), for instance the BlueHealth project in collaboration with the EU-supported Horizon2020, aimed at quantifying the health impacts and the well-being of existing and new actions linked to urban blue infrastructure.[705] Representing important landmarks in environmental Dutch policies, the Soil Protection Act (*Wet bodembescherming)* contains general yet resolute rules to prevent soil contamination *and the* Environmental Protection Act

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[702] Ibid

[703] Meijs, S., (2018) *Implementation Programme 2018 – 2019 National Climate Adaptation Strategy (NAS) of the Netherlands*, pp. 3-4, 10 [online] Available at: https://climate-adapt.eea.europa.eu/countries-regions/countries/netherlands

[704] Spatial Adaptation Knowledge Portal (n.d.) *Policy and programmes* [online] Available at: https://klimaatadaptatienederland.nl/en/policy-programmes/

[705] National Institute for Public Health and the Environment (n.d.) *Climate Change* [online] Available at: https://www.rivm.nl/en/climate-change

(Wet milieubeheer) represent one of the most important environmental law at the national law, establishing that permits must be obtained before certain activities may be implemented.[706]

In the framework of climate change mitigation, the national Climate Act lays out the objective of reducing the Country's greenhouse gas emissions by 49 percent by 2030, compared to 1990 levels, and a 95 percent depletion by 2050,[707] contributing to the ambitious and comprehensive Europe's goal to be the first climate-neutral continent by 2050, developed by the European Parliament and the Council Regulation No 2020/80, the European Climate Law. By approving the Climate Act, the Netherlands has chosen forcefully to focus on a single imperative target: curbing its GHG emissions. Furthermore, the Climate Act comprises the target of achieving a 100 percent carbon-neutral electricity supply by 2050 as energy conservations and renewable energies are regarded to be tools at the Netherlands' disposition during the climate transition. [708] In addition, the National Climate Agreement was concluded in June 2019 based on the core principle that curbing CO_2 emissions must be achievable and accessible for everyone, and whose measures will be introduced step by step to guarantee a gentle and equitable transition, cost-effective and climate-proof.[709] The Climate Agreement is an essential part of the Climate Plan, and of the National Energy and Climate Plan (NECP) that Member States of the EU are required to present to the European Commission. The Dutch government has submitted the Climate Plan and the NECP to the House[710] by the end of 2019.[711]

It is worth noting that an important push in domestic actions to tackle climate change in the Netherlands was given by the noteworthy State of the Netherlands v. Urgenda Foundation, whereas the latter represents a governmental association engaged in assuring a sustainable green climate-transition and reduce the impacts of global warming, suing the Dutch Government for not taking enough measure to tackle climate change hazards, especially the reduction of GHG emissions, severely impairing fundamental human rights, recalling art. 2 and 8 of the European Convention on Human Rights (ECHR), respectively the Right to life and the Right to respect

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[706] Ministry of Infrastructure and Water Management (n.d.) *Legislation and instruments* [online] Available at: https://rwsenvironment.eu/subjects/soil/legislation-and/

[707] Government of the Netherlands (2018) *Climate Policy* [online] Available at: https://www.government.nl/topics/climate-change/climate-policy

[708] Ministry of Economic Affairs and Climate Policy (2019) *Long term strategy on climate mitigation: the Netherlands,* p. 3. [online] Available at: https://unfccc.int/sites/default/files/resource/LTS1_Netherlands.pdf

[709] Government of the Netherlands (2018) *Climate Policy*

[710] The Parliament of the Netherlands comprise the *Eerste Kamer* (Senate) and the *Tweede Kamer* (House of Representatives).

[711] Government of the Netherlands (2018) *Climate Policy*

for private and family life.[712] Indeed in the end, the Hague District Court decided that GHG emissions in the Netherlands must be reduced by 25 percent compared to 1990 levels by the end of 2020 and lately in 2018 and 2019, the Court of Appeal in The Hague and the Supreme Court confirmed the District Court order.[713]

It can be deemed that the Netherlands is highly supporting and engaging in policies, plans, initiatives intended to reduce and mitigate the increasing changes of our climate. Certainly, its historical relationship with water and flood risks helped the Country and its inhabitants in the development of water resilience and management, other than learning to live in close proximity with water, turning it into a great resource, demonstrated by the elaborated and innovative system of dams and by the Delta Programme against flooding, storm surges and tidal waves. The Delta Programme symbolize a multi-layered and comprehensive approach, where governmental authorities work closely with regional actors and NGOs, businesses and water boards, and most notably with the Dutch people, setting the example for a winning and comprehensive governance system. The effectiveness of this peculiar model of governance, alongside the decentralized characteristic of the Dutch State, make it possible to address the multiple challenges posed by climate and environmental hazards, difficulties that are being overcome not only by the Delta Programme, but also by the numerous initiatives developed, from the Sand Motor to the successful Room for the Rivers and the green infrastructures and dikes spread throughout the country.

In conclusion, some last considerations and developments in the Dutch climate change field should be pointed out. In view of the Climate Adaptation Summit 2021, which was virtually held in the Netherlands last January, the Delta Commissioner Peter Glas stressed the urgency to adapt in front of the changing climate, requiring additional efforts and the acceleration of implementation processes, declaring "that is why I am urging the government, residents, and the business community to step up their climate adaptation efforts, on the basis of our shared responsibility […]" [714] Therefore, he formulated five recommendations in the purview of the 2022 Delta Programme, starting from the allocation of more resources to the Delta Fund, the investment of substantial sums in the connection of climate adaptation with other taskings, ensuring that water managing bodies are involved in the National Environmental Vision

[712] European Convention for the Protection of Human Rights and Fundamental Freedoms, (1953) Artt. 2, 8
[713] Government of the Netherlands (2018) *Climate Policy*
[714] Delta Programme Commissioner on the Presentation of Delta Programme 2022, (23 June 2021), DC-2021/393. Available at: https://english.deltaprogramma.nl/documents/publications/2021/09/21/dp-2022-in-english---print-version

(NOVI)[715] processes at an early stage, to make resources available for a Knowledge Programme focused on cross-border river discharges and discharge distributions, and lastly, concretizing climate adaptation goals with the derivative interim goals.[716, 717] In response to the proposition of the Delta Commissioner, the Dutch Cabinet stressed the importance of supporting the propositions put forward by the Commissioner, highlighting that making the Country climate and water-resilient by 2050 is a matter of the utmost relevance and therefore affirming that:

"I therefore endorse the Delta Programme Commissioner's appeal to the Cabinet to initiate, in consultation with the government umbrella bodies, a process to concretize the substantive climate adaptation goals (and the derivative interim goals), differentiated, if need be, at the regional level."[718]

In light of the intensity and occurrence of climate hazards, especially after the 2021 flooding that have hit Western European countries – Germany, Belgium and also the Netherlands – shed light on the urgency to tackle to climate change events and the imperative need to adapt. In this sense, following the National Adaptation Strategy, the specific Delta Programme, as well as the international goals set out by the Paris Agreement and the urgency stressed in the last Conference of the Parties, the Netherlands is truly engaged in turning into a resilient and climate proof reality.

1.1 Rendering cities climate-resilient: initiatives amongst Dutch municipalities

At this point, it is well established that climate hazards are increasingly affecting urban areas, including Dutch municipalities, developing the urgency to transitioning into smart and resilient centers. All municipalities in the Netherlands, from large to small, are exposed to the impacts of climate change, although the degree of vulnerability varies substantially within urban

[715] The NOVI (National Environmental Vision) is a policy framework which focuses on delivering a sustainable perspective for the living environment in the Netherlands, focusing on four areas, Groene Hart, De Peel, South Limburg, Zwolle region, Amsterdam and North Sea canal area, Rotterdam (Port of Rotterdam transition), North Sea Port District, and Groningen. Available at: https://www.fabrications.nl/portfolio-item/novi-future-perspective-nl/ and National Delta Programme 2022, p. 29. Available at: https://english.deltaprogramma.nl/documents/publications/2021/09/21/dp-2022-in-english---print-version

[716] Delta Programme Commissioner on the Presentation of Delta Programme 2022, (23 June 2021), DC-2021/393.

[717] The Minister of Infrastructure and Water Management, Cabinet response to Delta Programme 2022, (21 September 2021), IENW/BSK-2021/160042. Available at: https://english.deltaprogramma.nl/documents/publications/2021/09/21/dp-2022-in-english---print-version

[718] The Minister of Infrastructure and Water Management, Cabinet response to Delta Programme 2022, (21 September 2021), IENW/BSK-2021/160042.

areas.[719] In fact, environmental change is leading to more frequent heatwaves, heavier precipitations patterns, and more periods of drought, and the large percentage of paved areas in the city, combined with the increasing incidence of rainfall, can lead to greater damages through traffic disruptions, problems with infrastructure and with the well-being of citizens.[720]

Despite being a small country, the Netherlands is densely populated, embracing a melting pot of different cultures. The Dutch state is divided in approximately 400 municipalities, a number that used to be higher, but throughout the years some field of policy and service required a larger administrative-organizational authority, pushing neighboring towns to merge.[721] Nowadays, municipalities strictly collaborate with each other in a variety of fields, in turn involving city dwellers, thus creating a situation of strong cooperation between government bodies, regional and local authorities, citizens and civil society organizations.[722] From an environmental perspective, Dutch municipalities play an important role, as the well-being and livability of residents strongly depend on an array of principles, i.e., the quality and purity of air, water and soil, a significant challenge in many urban areas of the world today. In this sense, the European Union has had solid influence; many national environmental legislations have been affected by EU legislation, at the local level as well.[723]

To smoothen the cooperation and confrontation between municipalities, the Association of Netherlands Municipalities (or VNG in Dutch) was founded in The Hague in 1912, also functioning as an intermediary between the central government and Dutch cities, promoting its interests and help them in facing the most compelling challenges.[724] As part of international and multilateral cooperation, the VNG is active in many ways as it guides the secretariat of the Dutch delegation in the EU Committee of the Regions and the Congress of Local and Regional Authorities of the Council of Europe, also member of institutions as the European representative organization of local governments, the Council of European Municipalities and Regions (CEMR) and the world organization of local governments, United Cities and Local Governments (UCLG).[725]

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[719] Rovers, V., et al., (2015) *Climate Proof Cities – Final Report*, No 129/2014, p. 3. [online] Available at: https://www.researchgate.net/publication/274390866_Climate_Proof_Cities_-_Final_Report
[720] Ibid
[721] Figee, E., et al., (2008) *Local Governments in the Netherlands*, Association of Dutch Municipalities (VNG), p. 27. [online] Available at: https://www.vng-international.nl/wp-content/uploads/2015/06/Local_Government_in_the_Netherlands.pdf
[722] Ivi, p. 31
[723] Ivi, p. 47
[724] Ivi, p. 57
[725] Ivi, p. 59

For instance, the central government has solicited the Association of Netherlands Municipalities to organize a support programme to provide assistance to the many (small) municipalities and thirty of them received tailored - regional and national - support, by improving connection with activities under the Delta Plan on Spatial Adaptation, among the other things.[726] Worth mentioning, is the Joint Arrangements Act that came into effect in 2015, where Dutch municipalities, provinces and water authorities put their efforts together in public-law partnerships.[727] Organizations of cities are engaged in a series of important urban matters, from reducing poverty to the guarantee of gender equality and social security, exchanging a series of best practices and expertise. Of course, initiatives and networks of cities are widespread both at the national and regional level, other than the international one. The Climate Adaptation City Deal partnership was established in September 2016, in which fourteen public sector authorities and twelve (semi-) private organizations, aiming at moving climate adaptation in the urban environment to a superior and more evolved level.[728]

The City Deal on climate adaptation is part of the *Agenda Stad* (Dutch Urban Agenda), a collaboration between the central Dutch government, cities and stakeholders incorporating actions to foster economic growth, quality of life and innovation in Dutch cities.[729] Also, the Climate-proof City Toolbox, a platform that can be used to explore and analyze dozens of adaptation measures developed in provinces and municipalities, a valuable tool to exchange knowledge and good practices.[730] The Netherlands presently has 29 regional environmental services which have the purpose of supporting and advising municipalities, residents and companies in the sphere of environmental permits, also specialized in environmental supervision and enforcement in safety, air, noise, energy, waste and soil.[731] For instance, the Regional Implementation Service (RUD) Utrecht is a regional organization carrying out the most imperative environmental tasks – soil management, aviation, nature and landscape, water

[726] Ministry of Infrastructure and Water Management, the Ministry of Agriculture, Nature and Food Quality, and the Ministry of the Interior and Kingdom Relations (2021) *National Delta Programme 2022*, p. 74 [online] Available at: https://english.deltaprogramma.nl/documents/publications/2021/09/21/dp-2022-in-english---print-version

[727] Governments of the Netherlands (2016) *Cooperation between municipalities* [online] Available at: https://www.government.nl/topics/municipalities/cooperation-between-municipalities

[728] Ministry of Infrastructure and the Environment (2016) *Adapting with Ambition - National Climate Adaptation Strategy 2016 (NAS)*, December 2016, p. 33

[729] Delft Institute for Water Education (n.d.). *City Deal on Climate Adaptation | IHE* [online] Available at: https://www.un-ihe.org/news/city-deal-climate-adaptation

[730] Spatial Adaptation Knowledge Portal. (n.d.). *Climate-proof City Toolbox*. [online] Available at: https://klimaatadaptatienederland.nl/en/tools/climate-proof-city-toolbox/

[731] Omgevingsdienst NL (n.d.) *Environmental services in the Netherlands* [online] Available at: https://www.omgevingsdienst.nl/omgevingsdiensten/

- for the province of Uthrecht and its eleven municipalities, Amersfoort, Baarn, Bunschoten, Eemnes, Houten, Leusden, Lopik, Nieuwegein, Soest, Utrecht and Woudenberg, granting permits, enforcing provisions and giving advice.[732] Other examples are the Haaglanden Environmental Service, the Environmental Service Noord-Veluwe, and the Environmental Service Southeast Brabant.

As stated earlier, climate impacts vary from the incidence of extreme weather events, including rainwater and hailstorm most of the time leading to intense flooding, to increase in mean temperatures provoking the urban heat-island effect and periods of drought. Of course, there are certain climate effects for which the pertinent sectors are quite prepared; their adaptation capacity is significant, and measures have been embedded into existing policies and implementation programs.[733] For instance, the primary responsibility to manage urban heat stress falls to the public sector authorities in addition to their participation in the Delta Programme on Spatial Adaptation while municipal authorities and water management boards are jointly responsible for reducing the risk of flooding, where the Administrative Agreement on Water require that specific actions must be adopted to prevent extreme flooding, in which attention is also paid by the Delta Programme on spatial adaptation.[734] Also, as laid out by the National Heat Plan, municipalities must develop local heat plans taking into consideration the well-being of residents, especially of vulnerable people whereas provincial authorities, municipalities and private stakeholders must implement as well (spatial) measures to prevent urban heat cup.[735]

When dealing with rainwater events and flooding, Dutch municipalities have made the mindful choice of proposing smart measures, in the form of cooperation with residents and infrastructures, more technical solutions like the increase in the sewerage systems' capacities or separating the sewage system from the rainwater drain system to cope with heavy rainfall's effects, which indeed, should be made in cooperation with residents, since this process often involve private properties.[736] One of the key measures of Dutch water management is Three-Stage Process, entailing rainwater capture, storage and use – similar to the function of a sponge,

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[732] RUD Uthrecht (n.d.) *About the Regional Implementation Service Utrecht* [online] Available at: https://www.rudutrecht.nl/over-ons

[733] Ministry of Infrastructure and the Environment (2016) *Adapting with Ambition - National Climate Adaptation Strategy 2016 (NAS)*, December 2016, p. 27

[734] Ivi, pp. 35, 27

[735] Ivi, p. 35

[736] Dai, L., Wörner, R., & van Rijswick, F. M. W., (2018) Rainproof cities in the Netherlands: approaches in Dutch water governance to climate-adaptive urban planning, *International Journal of Water Resources Development*, 34(4), p. 653, DOI: : https://doi.org/10.1080/07900627.2017.1372273

thus managing water in an ecologically sustainable manner.[737] It implies that precipitation should be held as long as possible in the capture area; when this is no longer feasible, the storage areas - created for this end - should momentarily store the water while surplus water should be drained only when the former options have been employed to their full potential.[738]

The innovation of this approach rest in the first two steps: rather than immediately discharging rainwater and draining it, it is captured and stored, through the use of public infrastructure such as water squares in public areas, private measures by the installation green roofs, dividing rainwater from the sewage system or placing water tanks.[739] In the Municipality of Utrecht, an historical city crossed by water-canals the management of flooding problems in flood-prone territories, the City establishes working groups of municipal authorities and local residents.[740] For example, to handle the impacts resulting from an extreme rainstorm in 2014, several working groups - including citizens that participated in decision-making for rainproof management - were organized in the two harshest-hit areas, an ad hoc approach particularly advantageous when there are significantly varying problems, while on the other side it can be meaning lack of efficiency on spatial planning and organization.[741] In 2019, Utrecht developed a series of green infrastructures amongst which there are the worldwide renowned green roof in the City's bus shelters. The RBL Outdoor company carried out the job by placing 316 bus shelters curtailed with sedum roofs, 96 bus shelters equipped with solar panels, the bus shelters present LED lighting and bamboo seats, the shelters' floor platforms are built with recycled concrete and lastly the shelters are checked through electric vehicles and cleaned with filtered stormwater.[742] The green-roofed bus shelters are rendering the city climate-proofing in many ways as the roofs capture fine dusts; each square-meter of roof retains approximately 20 liters of water avoiding overloading the streets in case of heavy precipitations; thus having a cooling effect reducing the urban heat island effect (UHI).[743] Most importantly, green shelters foster urban biodiversity, granting the perfect natural ecosystem for insects and bees; they inspire citizens to install green infrastructures and generally improving their involvement with the

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[737] Dai, L., et al., (2018) Governance of the Sponge City Programme in China with Wuhan as a case study, *International Journal of Water Resources Development*, 34(4), p. 578, DOI: https://doi.org/10.1080/07900627.2017.1373637

[738] Dai, L., Wörner, R., & van Rijswick, F. M. W., *op. cit.*, p. 653

[739] Ivi, pp. 653-654

[740] Ivi, p. 657

[741] Ibid

[742] Spatial Adaptation Knowledge Portal (n.d.) *Green roof for Utrecht bus shelters* [online] Available at: https://klimaatadaptatienederland.nl/en/@221226/green-roof-utrecht-bus-shelters/

[743] Ibid

environment; they contribute to a carbon-neutral Utrecht; they promote low energy consumption and originate a feeling of security and comfort for passengers and commuters.[744]

Following the pathway of the Vertical Forest in Milan, in the city center of Utrecht, a new sustainable plan is being developed. The Wonderwoods Project by Stefano Boeri, which intends to create an innovative experience of coexistence between city and living nature, is part of a novel variant of the Vertical Forest, 105 meters high and approximately 200 apartments.[745] The green facades of the structure will present nearly 10,000 plants from 30 different species, 360 trees and 9,640 bushes and flowers, correspondent to one hectare of wood vegetation, resulting in a genuine urban ecosystem capable of generating approximately 41 tons of oxygen each year and capable of soaking up roughly 5.4 tons of CO_2 annually at full potential, in addition to a considerable amount of micro-particles, expressing the wholeness of this new eco-friendly tower.[746] Indeed, after the international success of the green-sheltered bus stops, every roof in the city district of Utrecht is to undergo a process of greening, following urban dispositions and the "no roofs unused" policy, as part of an effort to boost biodiversity in the city and establish a less stressful and joyful environment, in which the Wonderwoods projects perfectly fit.[747]

In the small Municipality of Tiel in the Province of Gelderland, the Water Square Tiel is a public square performing a dual function i.e., a public recreational area and a water storage facility in periods of heavy precipitations, characterized by four water basins: a bigger one functioning as sport field and three smaller basins that are employed for transportation, supplemental storage and infiltration of water.[748] In the Utrecht Province, the small village of Kockengen has a background of surface water flooding derived from land subsidence and severe rainfall, thus developing the Kockengen waterproof, a program consisting of three projects – the village project, the water project and the polder project - to transform Kockengen in a more resilient village together with the regional water authority and the province, each of them being responsible and for the funding of the project.[749] The village project, developed in

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[744] Municipality of Utrecht (n.d.) *Green-roofed bus shelters in Utrecht* [online] Available at: https://www.utrecht.nl/city-of-utrecht/green-roofed-bus-shelters-in-utrecht/

[745] Stefano Boeri Architetti (n.d.) *Wonderwoods* [online] Availabe at: https://www.stefanoboeriarchitetti.net/en/project/wonderwoods/

[746] Ibid

[747] Boffey, D., (2020) *Utrecht rooftops to be 'greened' with plants and mosses in new plan*, The Guardian [online] Available at: https://www.theguardian.com/world/2020/mar/27/utrecht-rooftops-greened-plants-mosses-vertical-forest

[748] Uittenbroek, C. J., et al., (2019) The design of public participation: who participates, when and how? Insights in climate adaptation planning from the Netherlands, *Journal of Environmental Planning and Management*, 62(14), p. 2538, DOI: https://doi.org/10.1080/09640568.2019.1569503

[749] Ivi, p. 2539

different stages between 2014-2024, aims at lifting the ground level of public space, streets and green space, and several smaller additional actions, where a group, instituted by the municipality and consisting of approximately 20 members of the community (representing business, farmers, residents and a nature conservation group) actively participated in the development of the project.[750] For instance, Climate workshops were organized by the group, in which residents participated alongside specialists to brainstorm about possible solutions to the surface water flooding issues while in the implementation stage, the municipality delivered multiple newsletters to keep the residents informed.[751]

Moving to the North Barbant region, the Municipality of Tilburg is striving to become carbon and climate proof by 2050, in line with the Country's goal. Indeed, the City is resorting to green and blue infrastructures, planting more trees and greenery, improving public parks with swimming pool and mixed deciduous forests serving as natural carbon-sinks, to reduce the urban heat-island, to hold rainwater and improve the soil, combatting droughts and dryness.[752] In the City's outskirts, the water park Moerenburg serves as a natural water storage, as the rainwater from the city is retained and can slowly infiltrate the soil; networks of cooling urban islands with space for water storage, cooling and evaporation in the form of water playgrounds, parks, squares, gardens and shady walking routes; private habitations are equipped against extreme weather with rainwater storages, green roofs and facades, and sufficient high floor levels to avoid stormwater nuisance.[753]

On a different level, the Blue Gardens citizens' initiative has the purpose of fostering water-friendliness of 1000 gardens in a three-year period, where residents can facilitate the climate-proof of the city by collecting rainwater or having it permeate the soil, by introducing greenery instead of pavement.[754] The organization launched a wide range of creative activities to realize water-friendly green gardens, such as the rain barrel campaigns where residents have received a discount on rain barrels and every time a resident purchased a discounted rain barrel, the organization would have a team of volunteers helping the buyer to carry the rain barrel and install its water overflow kit.[755] The coffee route consists in an open door spontaneous campaign

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[750] Ivi, p. 2540
[751] Ibid
[752] Municipality of Tilburg (2020) *Uitvoeringsagenda Klimaatadaptatie: Wij Werken Samen Aan Een Koel Tilburg*, pp. 6, 18
[753] Ivi, pp. 20-21, 23
[754] Spatial Adaptation Knowledge Portal (n.d.). *Boosting water friendliness in 1000 Tilburg gardens*. [online] Available at: https://klimaatadaptatienederland.nl/en/@215495/boosting-water-friendliness-1000-tilburg-gardens/
[755] Ibid

where nine residents, owning a water-friendly yard, welcomed those interested in getting useful advices to improve their gardens while enjoying a cup of coffee; also, the Blue Gardens initiative in collaboration with the Dutch NationalWater Traineeship set up the Pavement Lover campaign encouraging residents to replace their pavement with greenery and gravel.[756]

Important suggestions on the best practices used to make a garden water-resilient and green are provided under the Blue Gardens Programme. For instance the development of gravel strip or cases, where rainwater from the asphalted terrace or the roof can be retrieved and slowly sink into the soil;[757] ensuring a healthy soil for plants and vegetable gardens, creating small swamps, using rain shelters and rain-proof pavements, for instance through wooden decking, wood chips, shells – that can be used for garden paths and terraces – and also porous pavers which are suitable for driveways and parking spaces, since they are characterized by a grain structure with an elevated percentage of pores, making it permeable to water and air.[758]

Another important tool employed in the Blue Gardens and by citizens is the calculation of the garden score to acknowledge how climate and water-friendly is its own garden, incentivizing the residents with prizes, in order to develop more green and blue structures.[759] Indeed, the garden score on the 1000 Blue Gardens Tilburg website was carried out by 333 residents while the rain barrel campaign pushed 230 residents to purchase a rain barrel.[760] The initiator of the project, Janneke de Vries of the OpGoedeVoet foundation, discovered what works best to inspire citizens to improve and blue their gardens, concluding that citizens initiatives tend to mobilize more prompt responses among residents than government blueprint. The Blue Gardens Tilburg achieved notable results, stimulating the citizens, restaurants, shops, hotels and other urban activities to develop water-friendliness spaces and gardens, directly tackling the most intrusive impacts of environmental changes, most notably heatwaves, drought and extreme precipitations, and therefore demonstrating how private stakeholders and bottom-up approaches to climate change are valuable and widespread instruments in this fight, able to set a good example at the national and international level.

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[756] Ibid

[757] Huisje Boopmpje Beter (n.d.) *Gravel strip or gravel case* [online] Available at: https://www.huisjeboompjebeter.nl/acties/grindstrook/

[758] Huisje Boopmpje Beter (n.d.) *Water-permeable pavements* [online] Available at: https://www.huisjeboompjebeter.nl/acties/waterdoorlatende-verharding/

[759] To learn more on the Blue Gardens Initiatives: https://www.huisjeboompjebeter.nl/tilburg/ & https://www.huisjeboompjebeter.nl/acties/

[760] Spatial Adaptation Knowledge Portal (n.d.) *Boosting water friendliness in 1000 Tilburg gardens*.

The Municipality of Groningen, the capital city of the homonymous Province in The northern part of the Netherlands, is attempting to become a climate-proof city by 2050, just as Tilburg and many other municipalities in the Netherlands. In order to do so, Groningen has laid down an adaptation strategy as the City needed to establish new efficient plans for water, the sewer system, and green infrastructures, also supported by stress tests and a ladder of priorities.[761] This necessity for an ad-hoc adaptation plan arises from the new Environment Act, which will come into force in 2022 and integrates the policies and measures of the sectors involved in the physical environment, and also from the 2019 Healthy, Green, Happy Groningen Coalition Agreement, which was launched after the 2019's municipal elections, focusing on the well-being of its residents, on a prosperous cultural life and on a healthy environment.[762] The Adaptation Strategy is based on a ladder of priorities and goals; first, fostering collaboration amongst residents, entrepreneurs and local authorities; second, adopting an integrated future-oriented approach where climate adaptation actions are embedded with health, security and sustainability, and third, setting the good example not only for its residents and for parties across the globe and certainly, with the Global Adaptation Center Knowledge & Innovation offices, the City boasts a pioneer institution within its territory.[763]

In order to achieve this, the municipality has translated its adaptation approach into an implementation programme, specifying the actions and measures that the Municipality of Groningen will be developing and indicating the role it will be playing, starting from raising more awareness on climate adaptation (e.g., through the *Steenbreek*, a de-paving campaign), enhance collaboration and dialogue between stakeholders (e.g., the Groningen Green ten-step plan, where the municipality cooperate with nature and landscape organizations to address climate and biodiversity issues), support social initiatives, and introduce frameworks and enforce measures.[764]

The Hague, overlooking the north Sea in the South Holland Province, is home to the Dutch Parliament and Cabinet, the official residences of the Dutch royal family, the international headquarter of the UN's International Court of Justice and the International Criminal Court and of many European institutions. As a coastal city, The Hague is particularly exposed to water-

[761] Spatial Adaptation Knowledge Portal (n.d.) *Groningen uses ladder of priorities for adaptation strategy* [online] Available at: https://klimaatadaptatienederland.nl/en/?ActLbl=groningen-adaptation-strategy&ActItmIdt=24039
[762] Ibid
[763] Ibid
[764] Spatial Adaptation Knowledge Portal (n.d.) *Groningen sets down climate adaptation implementation agenda to tackle urgent situations* [online] Available at: https://klimaatadaptatienederland.nl/en/@240399/groningen-adaptation-implementation-agenda/

related extreme events, from flooding, to storm surge and coastal erosion. Yet, the City is growing vulnerable to heat stress events, hit by the UHI effects. Therefore, the Municipality is determined in increasing its adaptation to climate change, accelerating the energy and climate transition with the ambition to become climate-neutral by 2030. At the moment, The Hague is almost fully dependent on natural gas to heat its buildings, has around 80 plants for thermal energy storage and as of the end of 2017, there were more than 80,000 solar panels while in the Zuidwest district much effort is being put in the first source of geothermal heating in a Dutch city, while also enhancing the transition in other neighborhoods by supporting and involving residents, in make buildings ready to be linked with clean energy sources, supported by the Green Neighborhoods Campaign.[765] As stated in the National Delta Programme, the City carried out stress tests for extreme weather, revealing for instance that some streets and neighborhoods in The Hague are even more vulnerable to flooding, pushing residents, government authorities – water boards and the Province – and also private enterprises, to take prompt action on the matter, for instance, through the Climate Adaptation City Deal, the South Randstad Community of Practice, the Resilient Cities network (The Rockefeller Foundation) and the EU Interreg project Nature Smart Cities.[766] Financed by the European Unions' Intereg 2 Seas Programme, the Nature Smart Cities project supports cities to address climatic challenges developing green and cooling infrastructures and rainwater storages, with 8 City Partners – Antwerp, Bruges, Cambridge, Lille, Kapelle, Southend on Sea, Streekvereniging Zuidrand and The Hague - and 3 Academic Partners in the UK, Belgium, The Netherlands, and France have joined forces.[767]

In the specific case of the Hague, the pilot project is taking place in the Laak District, an area particularly sensitive to heat and intense rainfall facing problems on living conditions and social cohesion, and as part of its strategy, The Hague already has specific plans for the regeneration of public spaces and the sewer system renovation while the Nature Smart Cities pilot assists in incorporating innovative climate resilience measures into these plans.[768] The European investment consists of two sub-pilots, divided as follows: the first, concluded in 2021, included

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[765] Municipality of The Hague (2019) *Memorandum on Sustainability. Clean energy in a green city*, pp. 15, 19 [online] Available at: https://www.denhaag.nl/en/in-the-city/nature-and-environment/hague-plan-for-a-sustainable-future-.htm

[766] Ivi, p. 25

[767] Nature Smart Cities (n.d.) *A business model for greener cities* [online] Available at: https://naturesmartcities.eu/business_model

[768] Nature Smart Cities (n.d.) *Building Climate Resilience of the Laak District* [online] Available at: https://naturesmartcities.eu/pilots/75#83

the award-winning Urban Waterbuffer. [769] into the freshly regenerated Wijkpark Cromvliet district while the second, concerns the small area of Van Musschenbroekstraat.[770] In the first scenario, the UWB is composed of a 70 cubic meters case system to provisionally retain water, which later is led to a 30 square meter biofilter where it is purified and infiltrated to a 35,000 cubic meters deep subsurface aquifer, then ready to be used in particularly warm periods, when it can be pumped up and used to irrigate the urban farm's vegetation and the park's local vegetable garden.[771] With this project, the Hague has paved the way with respect to expanding the process for implementing a ground-breaking solution for what is nowadays becoming an ordinary problem, in a renovation design in urban public spaces, making the UWB pilot an emblematic project.[772]

The second sub-pilot concerns the *Van usschenbroekstraat*, where a small square parallel to this street is being greened in close cooperation with the local people, where a minimum of 200 squared-meters pavement will partially be replaced with shrubs and small trees, making the zone more suited for the existing trees to flourish and being sure that the flora performs as well as possible in providing optimal ecosystem and well-being services. To accomplish this, the state of the soil will be strengthened through the use of composting, earthworms and mulch, and the insertion of a vegetative layer, so that the second sub-pilot will be completed by mid-2022.[773]

In the framework of the EU Interreg 2 Seas Programme, the Hague is participating on the PlastiCity Project, which has the purpose of developing repeatable strategies and solutions able to boost circular economy and recycling rates in urban environments from 20-30 percent to over 50 percent, generating new value chains and designing new sustainable products, inducing behavioral change in urban dwellers.[774] As of December 2021, The Hague was working on the first pillar of the PlastiCity hub, a physical location for all stages involved in the plastic recycling process, starting from waste collection, processing and finally, recycling.[775] Also, The

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[769] The purpose of the Urban Waterbuffer (UWB) is the gather, treatment and longer retention of rainwater in urban areas, without creating strife with other surface functions. By using groundwater wells to permeate the harvested rainwater, and store it in deeper underground aquifers, the water remains available and can be recovered for use in case of need. Available at: https://www.kwrwater.nl/en/projecten/the-urban-waterbuffer/

[770] Nature Smart Cities (n.d.) *Building Climate Resilience of the Laak District*

[771] Ibid

[772] Ibid

[773] Ibid

[774] Interreg 2 Seas Mers Zeeën (n.d.) *PlastiCity* [online] Available at: https://www.interreg2seas.eu/en/PlastiCity

[775] Interreg 2 Seas Mers Zeeën (n.d.) *PlastiCity - The Hague* [online] Available at: https://www.plasticityproject.eu/regions/the-hague/

Hague joining forces with ten beach pavilions and 60 SMEs, acquired under the PlastiCity projects the Resource bike, for the collection of plastic waste and other industrial waste flows, around the city.[776]

An important scheme developed in the City's Cannenburglaan neighborhood, is the construction of infiltration basements, which prevent flooding during torrential rain and enable stormwater to penetrate into the groundwater.[777] More precisely, an infiltration basement allows the water sufficient time: because of its large space, act like a shield where the water is temporarily stored; subsequently, it can gradually infiltrate into the soil, blocking any dirt and dust.[778] The city of The Hague presented several of this variety of infiltration basements, since due to their substantial supporting power, infiltration basements are often introduced in urban environments with traffic problems as they can be found beneath large surfaces, such as parking areas, schoolyards, and playgrounds.[779]

The Municipality is attempting to create a healthy green environment for its residents, its international stakeholders and tourists and at the same time, is working to introduce water-friendly infrastructures and render the City water-resilient to the heavy climate hazards, for instance by working with the Delfland Water Authority to improve water quality, or through the new landscape park in Madestein that creates an ecological corridor through the Westland area connecting the southern belt of the city with the green Midden-Delfland.[780] In 2016, The Hague was selected from over 1,000 applications to be part of the 100 Resilient Cities Network, pioneered by the Rockefeller Foundation, developing a Resilience Strategy helping the City to strengthen the capacities of its communities, institutions, entrepreneurship and systems to better confront future shocks and stresses.[781]

Like many other European and Dutch cities, the Municipality of Breda, in the North Barbant Province, is enduring the impacts of climate change, struggling with the unsustainable urbanization patterns of the past, which in turn requires innovative and resilient solutions to

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[776] Ibid

[777] Spatial Adaptation Knowledge Portal (n.d.) *Invisible water buffer: infiltration basement underneath new buildings in The Hague* [online] Available at: https://klimaatadaptatienederland.nl/en/@237511/invisible-water-buffer-infiltration-basement/

[778] Ibid

[779] Ibid

[780] Municipality of The Hague (2019) *op. cit.*, p. 26

[781] 100 Resilient Cities Network (2019) *The Hague Resilience Strategy*, pp. 10-11. [online] Available at: https://resilientcitiesnetwork.org/networks/the-hague/

boost the urban environment and well-being.[782] As part of the City plan for the Nieuwe Mark, the river crossing the City, the GreenQuays Project aims to develop and test green techniques - trees and bushes in the quay walls, sustainable material choices and drainage system - designed to assist in developing a vertical ecosystem and to enhance the growth of herbaceous plants, ferns and mosses, a nature-inclusive development of the quays and bordering public area.[783] A major challenge in the development of the GreenQauys is the limited project duration, which does not enable to have strong monitoring and evaluation results to be employed for the design of the Real-Life pilot project and for fully proving the validity of the outcomes, since time is shorter compared to vegetation growth.[784] In the GreenQuays project the Physiological Equivalent Temperature (PET) is used as an indicator of outdoor thermal comfort; the thermal index refer to how peoples feel an external thermal environment as it outlines the combined perception of air temperatures, wind speed, humidity and incoming solar and thermic radiation, including the emitted portion from surrounding buildings.[785] The microclimatic analysis shows that the Physiological Equivalent Temperature in some areas, shift from extreme heat stress (40-46 °C) to slight heat stress (25-28 °C), while in other places the difference is less marked yet considerable.[786]

As of October 2021, the project was at mid-term, having tested different designs in a lab test and at a small-scale test site, and therefore, the construction was in procurement and expected to start in 2022, even though delays due to the Covid-19 pandemic occurred.[787] The PET indicator employed in the project, shows that the plantation of trees, shrubs, with proper ventilation and a proper management for the vegetation, contributed to the cooling of the area, as fostering urban green areas and elements such as trees, green facades and roofs are good ways to adapt to climate change hazards, in particular to cool during more frequent heatwaves and to permeate rainwater, while creating a pleasant urban landscape and regenerating Breda.[788]

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[782] Georgi, B., (2021) *GreenQuays Journal 1: the seven major implementation challenges*, Urban Innovative Actions. [online] Available at: https://www.uia-initiative.eu/en/news/greenquays-journal-1-seven-major-implementation-challenges

[783] Ibid

[784] Ibid

[785] UIA - Urban Innovative Actions. (2021). *Making Breda's nature-inclusive quays also climate-responsive.* [online] Available at: https://www.uia-initiative.eu/en/news/making-bredas-natureinclusive-quays-also-climateresponsive

[786] Ibid

[787] Georgi, B., (2021) *GreenQuays Journal 2: Progress on tackling the major implementation challenges*, Urban Innovative Actions. [online] Available at: https://www.uia-initiative.eu/en/news/greenquays-journal-2-progress-tackling-major-implementation-challenges

[788] UIA - Urban Innovative Actions. (2021). *Making Breda's nature-inclusive quays also climate-responsive.*

The Municipality of Breda is also taking part to the Interreg Europe project WAVE - WAter-linked heritage Valorization by developing an Ecosystemic approach, with the main goal of restoration of the former river and harbor to reach a wide variety of objectives concerning economy, climate change, quality of life, and water heritage.[789] In the Municipality, the main harbour and river disappeared in the period 1940s-1960s, replaced by circulation and parking facilities, while in the 1990s a plan was drafted to restart the water course, with the intention to foster economic development of the inner city, strengthen the connection between the city center and more surrounding vulnerable areas, meet the challenges of climate change, develop an ecological zone through the inner city giving a meaning again to the relationship between the adjacent heritage and water. In 2007 the new port was opened followed by the river in 2008, with one-third of the watercourse back and one-third still to be reopened, a phase which will be carried out in combination with a new urban park, with a lot of efforts put to the greening of the normally river quays, a project that goes hand in hand with the GreenQuays project.[790]

The results obtained are remarkable as nearly €200 million already invested in real estate along the new course and new investments are on track to be realized, while the restoration of the area led to an increase of about 15 percent in spendings and approximately 300 additional positions, benefiting urban dwellers, water management boards, investors and urban shopkeepers, also fostering leisure and the touristic industry.[791] More broadly, the City has developed a comprehensive environmental plan – Breda Environmental Vision 2040 - to encompass the long-term choices and insights until the year 2040, describing the most imperative challenges the Municipality is facing, the main local and regional interests, the best choices in implementation patterns, and what priorities are to be set in the design of a resilient and climate-proof Breda.[792]

Municipalities in the Netherlands boast a certain degree of autonomy due to the decentralized unitary structure of the Dutch state, cooperating with the national government and the regional authorities in a range of subject matters, including the environmental one. This is because of the high degree of involvement of private stakeholders in developing and launching initiatives able to cope with climate hazards, as it was shown in the case of the Blue Gardens citizens, the initiative proposed by the dwellers of Tilburg, supporting each other, sharing and exchanging

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[789] Interreg Europe (n.d.) *De Nieuwe Mark* [online] Available at: https://www.interregeurope.eu/policylearning/good-practices/item/4480/de-nieuwe-mark/

[790] Ibid

[791] Ibid

[792] Municipality of Breda (n.d.) *Environmental vision* [online] Available at: https://www.breda.nl/omgevingsvisie

best practices to foster water-resilience in private habitations. Indeed, to facilitate the bottom-up approaches and to encourage residents' own responsibilities, the central government is decentralizing governmental competences vesting them in Dutch municipalities.[793] Therefore, a singular characteristic of Dutch Municipalities is the great involvement they have with businesses, the academia, regional authorities, but especially with residents, representing the beating heart of cities, directly experiencing the urban life with all its pros and cons, and therefore widely aware of what is needed to overcome and adapt to climate hazards. The majority of Dutch cities are transitioning towards climate-proof and carbon-free realities, following the national ambition to become a climate-positive country by 2050, through the development of green and blue infrastructures, whereas the nature represents one of the best ways to adapt to the rapid changing climate, they are recreating green urban areas where its residents coexist with nature, as demonstrated by the city of Nijmegen, in the Gelderland Province, awarded as European Green Capital in 2018.

2. Rotterdam: international port city and delta leader

From a small fishing village by the river to a global maritime hub, the Municipality of Rotterdam, in the South Holland Province and on the Rhine-Meuse-Scheldt Delta - is a major transshipment center through which commodities are exchanged throughout Europe and internationally, earning the title of "the gateway to Europe," where before the global pandemic affected international trade, about 469 million tons of cargo moved across the port city Rotterdam.[794][795] Historically, the construction and consolidation of the of the Nieuwe Waterweg enable Rotterdam to grow into the major transit port of Northwest Europe, also resulting in the increase of the tidal power of the river near the City, leading to more recurrent flooding of the region beyond the dikes, including the "water city".[796] Therefore, it is undeniable that the Port and the City have experienced a prosperous growth throughout history, thanks to their mutual development, but the threat of climate change, environmental breakdown, and the necessity of transitioning towards a more circular economy, makes change ever more

[793] Dai, L., Wörner, R., & van Rijswick, F. M. W., *op. cit.*, p. 660
[794] NL Flag, (n.d.) *Gateway to Europe* [online] Available at: https://nlflag.nl/business-nl/gateway-europe/
[795] Hein, C., & Littlejohn, A (2021) *Rotterdam Past, Present and Future: a Global-Port City at the Crossroads*, PORTUS Magazine No 42, December 2021, RETE Publisher, Venice, ISSN 2283-5789 [online] Available at: https://portusonline.org/rotterdam-past-present-and-future-a-global-port-city-at-the-crossroads/
[796] Meyer, H., (2019) *Sustainable delta landscapes need smarter port city regions*, PORTUS Magazine No 8, November 2019, RETE Publisher, Venice, ISSN 2039-6422, pp. 10,12

imperative.[797] The adaptation need and management in the delta area or Rotterdam, and beyond, is the relevant National water authority and the port authority, namely the Rijkswaterstaat (RWS) and the Port Authority of Rotterdam which became private in 2004.[798]

The City of Rotterdam, bearing in mind the domination of fossil fuel related port areas, should enact an efficient and smart transition, adapting the area to climate change mitigating its impacts, turning its gaze towards a wider regional plan coordinating actions and cooperation among the ports of the Delta region.[799] Nowadays, 19 percent of the overall CO_2 emissions produced by the Netherlands derive from the Delta region, thus pushing the national climate goal to curb CO_2 emissions by 2030 while Rotterdam's objective is to realize a sustainable port and industrial complex by 2050.[800] The Port of Rotterdam Authority have foreseen a strategy to reduce GHG emissions divided in three stages. The first step is based on efficiency, developing infrastructure, carbon capture, utilization and storage (CCUS) where between 2018 and 2025, the attention will be on the provision and reuse of surplus energy and storage or deployment of captured CO_2.[801]

In this framework, through the Porthos project, companies will provide their CO_2 to a collective pipeline running through the Rotterdam port area and later, transporting CO_2 store it gas fields on the bottom the North Sea.[802] The second step (2020-2030), towards a new energy system, is mainly involved in making energy use by industry sustainable (for instance blue and green hydrogen).[803] Under the Rotterdam Climate Agreement achieved after five climate roundtables, 49 climate deals with concrete measures were drafted, so that together CO_2 emissions will be halved over the next 10 years.[804] Amongst the 49 deal, following the goal to develop a carbon-free port, the H-Vision project aims at producing blue hydrogen from natural and refinery gas to enable industries to become more sustainable and the hydrogen sector to take off assisted by the inclusion of offshore wind-generated electricity.[805] Lastly, the third step

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[797] Hein, C., & Littlejohn, A., *op. cit.*

[798] Meyer, H, *op. cit.*, pp. 15-16

[799] Ivi, p. 15

[800] Rotterdam Maritime Capital of Europe. (n.d.). *Energy Transition - Rotterdam Maritime Capital of Europe*. [online] Available at: https://www.rotterdammaritimecapital.com/challenge/energy-transition

[801] The Rotterdam-Moerdijk Industry Cluster Work Group (2018) *Three Steps Towards a Sustainable Industry Cluster. Rotterdam-Moerdijk in 2050*, p. 9. [online] Available at: https://www.portofrotterdam.com/en/port-future/energy-transition/strategy-and-vision

[802] Porthos, (n.d.) *The project* [online] Available at: https://www.porthosco2.nl/en/project/

[803] The Rotterdam-Moerdijk Industry Cluster Work Group (2018) *Three Steps Towards a Sustainable Industry Cluster. Rotterdam-Moerdijk in 2050*, p. 9

[804] Rotterdams Klimaatakkord (2019) *Rotterdam Climate Agreement*, p. 6

[805] Ivi, p. 13

is focused on the renewal of raw materials and the use of sustainable resources, for instance vast supply of green electricity and hydrogen, advancement of international recycling hub, biomass and hydrogen centers.[806]

It cannot be denied that the Rotterdam region has added significant value for the national economy thanks to the port- and industry cluster, being the spot for many international companies and providing direct and indirect employment for almost 400,000 people.[807] Yet, at the present-day numerous initiatives, collaborations with regional and international stakeholders and pilot projects are under way to reduce the carbon footprint that the Rotterdam Port area produce in the Delta Region and in the Country, emerging as a frontrunner in technological and spatial innovation, whereas Rotterdam's long history as an international port city and its resilience as delta center, remain essential to its residents.[808]

As coastal city, Rotterdam is widely affected by water-related climatic hazards, as intense precipitations could eventually lead to urban flooding. The first option to face these challenges, as proven by many other cities, is the introduction of water retention and water-retarding (green) facilities in both public spaces and private habitations, as 60 percent of the space within the city is privately owned.[809] Also, despite being a gradual process, the rise in sea level has consequences for the City, situated in the lower borders of the Rhine-Maas Delta, resulting in seepage pressure, coastal erosion, impacts on water quality, and storm surges, especially if dikes and flood defenses such as the *Maeslantkering* barrier do not succeed in coping with the average higher water levels.[810] The Sparta stadium, situated in a zone exposed to intense flooding, has developed the Urban Water Buffer which captures, filters and stores rainwater from the surrounding area, and reusing it when necessary, setting the good example of a circular and climate-adaptive measure.[811]

The Municipality is also affected by other widespread urban climate stresses, starting with the increase in average temperatures leading to more heatwaves, of which four hit Rotterdam between 2000-2018, creating in denser urban areas a gap of +3 °C of yearly average temperature and +8 °C on sunny days.[812] In this context, the Municipality, along with the cities of Athens

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[806] The Rotterdam-Moerdijk Industry Cluster Work Group (2018) *Three Steps Towards a Sustainable Industry Cluster. Rotterdam-Moerdijk in 2050*, p. 9

[807] Rotterdams Klimaatakkord (2019) *Rotterdam Climate Agreement*, p. 11

[808] Hein, C., & Littlejohn, A., *op. cit.*

[809] Rotterdam Weatherwise Urgency Document, 2019, pp. 28,48

[810] Ivi, p. 19

[811] Ivi, p. 24

[812] Ivi, pp. 31, 33

and Paris, created an app – Extrema Rotterdam - with personal advice on the risks of health issues as a result of the heat, calculating this risk on the basis of the present weather, age, gender and state of health, displaying maps of the city showing the cool spots and drinking water locations within the city.[813] Other issues that the Municipality has to face as a consequence of global warming is the groundwater – often leading to land subsidence - as in a number of districts there is excessively high groundwater levels, manifesting itself in wet basements, pools of water and too wet gardens while in other districts the groundwater is disproportionately low.[814] In framing these urban stresses, the online platform *Rotterdam WeerWoord* provides information on Rotterdam's weather and most common climate events, offering specific insights on what the citizens at the frontline are doing to adapt, sharing their stories, showing – and confirming – that what the City cherish the most is the voice of its citizens, developing small-scale climate-adaptive measures in the public space at street and private levels, cooperating with local and regional authorities, businesses and other private actors, but mostly with Rotterdammers.[815]

At the municipal level, several initiatives were launched, and multilateral agreement were concluded to cope with environmental changes, turning major threats into opportunities.

Initiated by the Port of Rotterdam, the City of Rotterdam, employers' organization *Deltalinqs*, and DCMR Environmental Protection Agency *Rijnmond*, the Rotterdam Climate Initiative establishes a movement in which government, organizations, companies, knowledge institutes, and citizens jointly cooperate to achieve a 50 percent reduction of GHG emissions, adapt to climate change, and promote the economy in the Region.[816] It is in the framework of the Rotterdam Climate Initiative that the Rotterdam Climate Proof (RCP) was delineated, with the purpose of making the city completely climate-proof by 2025 through climate change adaptation and prevention, and based on the following pillars: becoming a leading center for water knowledge and expertise on climate change, investing in climate solutions, and lastly export innovations and knowledge developed within the City.[817] In line with the RCP's desire to establish a coherent adaptation strategy, the Rotterdam's Adaptation Strategy (RAS) was developed in 2010 and fully appointed in 2013, firstly focusing on the sustainable protection against flooding, and secondly, being prepared for other pressures such as higher incidence of

[813] Ivi, p. 23
[814] Ivi, p. 40
[815] Ivi, p. 48. To learn more on Rotterdam WeerWoord: https://rotterdamsweerwoord.nl
[816] Municipality of Rotterdam (2010) *Rotterdam Climate Proof Programme (RCP)*. Available at: http://deltacityofthefuture.com/documents/RCP_ENG_2010_def.pdf
[817] Ivi, p. 4

heat waves, increased intense precipitation, groundwater salinization, and an augmented variety of groundwater levels.[818]

The RCP is based on three fundamental pillars, beginning with the development of proper knowledge that will lead Rotterdam into a leading national and international water expertise and climate-proof city moving on the developing into a global testing bench in the sphere of delta technology and urban water management and thus, contributing to the realization of sound, healthy, and engaging living environment; lastly, positioning Rotterdam as an inspiring model to delta cities in the Country and internationally.[819] Also, the RCP revolves around five subject-related themes (flood management, accessibility, adaptive building, the urban water system, and the urban climate) and approximately seven pilot projects, amongst them the C40's Connecting Delta Cities Network, the floating pavilion in Rotterdam, Smart Delta City and so forth.[820]

In the Stadshavens district, the floating pavilion represent one of the landmarks of the City not only for its aesthetic uniqueness but especially because of its climate-safe, innovative, sustainable and flexible qualities.[821] As the water levels rise, the floating pavilion will accordingly rise, the building's heating and air conditioning mechanism rely on solar energy and surface water, it includes several climatic zones; the energy is used in a smart way only in places where it is needed at specific moments, setting the example for the development of water structures, completely resilient and climate-proof.[822] Sustainable and phase change materials were employed to temporarily preserve energy, hence increasing the effect of night cooling, vegetation walls regulate the high humidity, improve air-quality and act as noise isolation, and lastly the outdoor façade contains three layers of ETFE foil and are inflated with low-pressure air to deliver insulation and to oppose wind loads.[823] The use of local sources of water and energy ensures that the Floating Pavilion uses 60 percent less energy than a building with the same functions and volume, therefore responding to the holistic climate goals of Rotterdam to reduce CO_2 emissions by 50 percent in 2030.[824] As many other projects, the development of the Pavilion create a situation of comprehensive collaboration between diverse stakeholders,

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[818] Ivi, p. 7
[819] Ivi, p. 9
[820] Ivi, p. 13
[821] Municipality of Rotterdam (n.d.) *Rotterdam Climate Proof Adaptation Programme: connecting water with opportunities*, p. 8
[822] Ibid
[823] Deltasync (2014) *Floating Pavilion: information brochure*, pp. 8-9 [online] Available at: https://www.blue21.nl/portfolio/floating-pavillion/
[824] Ibid

spreading awareness and engaging multiple research and education institutions, such as Delft University of Technology, Rotterdam University of Applied Sciences, Albeda College, Erasmus University Rotterdam - Dutch Research Institute for Transitions(Drift) and Urgenda, also involving students from many different fields and organizing information meetings for stakeholders, once again demonstrating the centrality of public and private governance in these patterns.[825]

As mentioned above, in 2019 more than 100 Rotterdam-based companies, institutions and governmental authorities jointly prepared the Rotterdam Climate Agreement with the aim to connect parties to collaborate on the Rotterdam Climate Objectives, i.e., reach a trend break in CO_2 emissions within four years going from an annual increase to a sharp reduction and 49.6 percent decrease in GHG emissions in 2030 compared to 1990 levels.[826] In the framework of the Rotterdam Climate Agreement, 49 deals were made between the parties on a series of key priorities, in the fields of port and industry, clean energy, mobility, built environment and circular and consumption. For instance, in the field of the built environment, the deals focused on the development of new energy-efficient apartments and habitations in different districts of the city, particularly developed by real estate agencies, housing associations and architectural firms. In the field of mobility, the main goal is to enhance public transportation, car and bike sharing other than fostering the use of private bikes, also amongst children, to spur responsibility and a genuine cycling culture, to make Rotterdam accessible, well-connected and resilient, a city that encourages healthy and sustainable habits. A project developed in this sector is to transform the Nieuwe Binnenweg in West Rotterdam into a one-way street, eventually resulting in result in better circulation, safer, cleaner and healthier conditions.[827] In the context of sustainable mobility, the Rotterdam Traffic Plan 2015-2030 seeks to convert the city center into healthy, appealing and dynamic streets by reducing use of cars and increasing the comfort of public areas.[828] The Municipality Mobility Department, applying the concepts of Barcelona's Superblocks and open streets, is attempting to increase active mobility and in this sense the Superblock Oude Westen Project aims to improve streets through the reduction of motorized

[825] Ivi, p. 14
[826] Rotterdams Klimaatakkord (n.d.) *The Agreement* [online] Available at: https://rotterdamsklimaatakkoord.nl/klimaataanpak/het-akkoord
[827] Rotterdams Klimaatakkord (2019) *Rotterdam Climate Agreement*, p. 27
[828] C40 Cities (2019) *Benefits of Walking and Cycling: Rotterdam Superblock Oude Westen* [online] Available at: https://www.c40knowledgehub.org/s/article/Benefits-of-Walking-and-Cycling-Rotterdam-Superblock-Oude-Westen?language=en_US

traffic share from 25 percent to 5 percent, by fostering cycling and walking infrastructure and decreasing street-level parking.[829]

Developed by the Municipality, the Municipal Sewerage Plan is responsible for the sewerage policy of the city, describes, among other things, the updated situation of sewerage management, the most urgent objectives and programmed measures in line with Rotterdam *Weerwood's* plan to cope with climate change.[830] The Administrative Agreement on Climate Adaptation was signed in 2018 to boost climate adaptation and implement the actions proposed in the framework of the 2018's Delta Plan on Spatial Adaptation, on behalf of Minister Cora van Nieuwenhuizen of Infrastructure and Water Management and by the Association of Dutch Municipalities (VNG), the Union of Water Boards (UvW) and the Interprovincial Consultation (IPO).[831] Lastly, the City Deal Climate Adaptation is a cooperation agreement between fourteen public associates, including Rotterdam and twelve (semi)private partnership partners, working together on a series of pilot projects, with the purpose or achieving the Delta Decision on Spatial Adaptation goals, i.e., to develop, build and manage a climate-proof Rotterdam by 2050.[832]

The Municipality of Rotterdam can be considered one of the most important pioneers of climate change adaptation and resilience in the Netherlands, setting the example at the regional and international level. In this sense, the City is widely embedded in international and EU climate initiatives and networks. Rotterdam, like many other municipalities is part of the 100 Resilient Cities – along with The Hague – pioneered by the Rockefeller Foundation, receiving throughout the years support, knowledge and experience from the network, helping the City to promote and export the skills and services of some local private partners (e.g., private companies such as Deltares, Arcadis and TNO which are now active in Denmark, India and the US).[833] Also, the dire experience of Hurricane Katrina in New Orleans and Hurricane Sandy in New York and New Jersey generated widespread interests in the resilient strategies developed by the Delta City, attracting numerous investments and generating an exchange of expertise and innovation.[834] Indeed, in the aftermath of Hurricane Katrina, Dutch experts assisted New Orleans (NOLA) by hosting the "Dutch Dialogues" and learning from this communication

[829] Ibid
[830] Municipality of Rotterdam (n.d.) *Municipal sewerage plan (GRP)* [online] Available at: https://www.rotterdam.nl/wonen-leven/grp/
[831] Municipality of Rotterdam (n.d.) *Underground Water Storage Museumpark Garage* [online] Available at: https://www.rotterdam.nl/wonen-leven/waterberging-museumparkgarage/
[832] Ibid
[833] 100 Resilient Cities (n.d.) *Rotterdam Resilience Strategy: Ready for the 21st Century*, p. 16 [online] Available at: https://resilientcitiesnetwork.org/networks/rotterdam/
[834] Ivi, p. 15

contributed to the advancement of NOLA's Integrated Water Management Plan, resulting in the participation of NOLA in the Connecting Delta Cities network and the two centers are further interconnected by their involvement in the 100 Resilient Cities program.[835]

The 100 Resilient Cities resilience strategy is based in important goals such as enhancing a healthy and balanced society, to guarantee a clean energy transition and an efficient adaptation plan for the city and its residents, to develop modern infrastructures. Among the most remarkable projects launched in the framework of the 100 resilient network the Rotterdam Port Authority along with the Dutch Research Institute for Transitions (DRIFT) cooperate to establish a bio–based port platform, to ensure a transition agenda, from a fossil fuel–based energy scheme to a bio–based economy, and taking the lead on this agenda could also translate in a competitive advantage for the Municipality, allowing knowledge sharing with a number of other port or post–industrial cities.[836] Also, in the field of fostering urban climate adaptation, the flourishing Zomerhofkwartier district – commonly known as ZoHo - together with the support of residents, businesses, organizations and visitors has experienced a steady urban regeneration, becoming a successfully integrated urban resilient hub.[837] The climate hazards that the ZOHO neighborhood is facing are threefold, namely increasing heavy rain events, wider periods of drought and deeper periods of heat stress, each of them bearing their own specifics.[838] After the endorsement of the Rotterdam Adaptation Strategy, ZoHo was appointed as the district to experiment with many disparate ways of climate proofing an urban area, through physical interventions dealing with excessive storm water, heat stress and long periods of drought on one hand while increasing the quality of public space and livability on the other. Of course, the projects are followed by numerous stakeholders that share responsibilities in the organization and maintenance.[839] Some of the projects are completed and accessible while others are yet to be completed. For instance, the well-known Benthemplein Watersquare combines temporary water store in times of intense rainfall with the improving of the quality of urban public space, as the funds are invested in water storage facilities, visible and pleasant, while generating opportunities to build a recreational space for the neighborhood, guarantee environmental quality and resilience to most intense climate hazards.[840] Another example is

[835] Ivi, p. 89
[836] Ivi, p. 72
[837] Ivi, p. 82
[838] Municipality of Rotterdam (2017) *Zoho Climate Proof District* [online] Available at: https://issuu.com/jesus_martin_hurtado/docs/urbanisten_climate_adaptive_zoho_lr
[839] Ibid
[840] Ibid

given by the ZOHO-rainbarrel, which is a smart device allowing to control water storage capacity within the system, and the composition of the Katshoek Rain(a)way Garden: a subtle relation between seasonal flowers, ornamental grasses create a sustainable area that serves as natural buffer for heatwaves and intense precipitations.[841]

In conclusion, worth mentioning is the leading role that the Municipality of Rotterdam has adopted in the Connecting Delta Cities Network, under the international C40 Cities umbrella, sharing experiences, knowledge and best practices with delta cities around the world, from the nearest London to the farthest Asian realities of Jakarta and Ho Chi Minh City, and New York and New Orleans. More on the Delta Cities Network will be shown and explained in the next paragraph.

2.1 Rotterdam as a leading delta city: Connecting Delta Cities Network

It is now well established that by the middle of this century, the majority of the world's population will live in urban areas, especially in low-rise cities or near deltas, flood plains or coastal regions, stemming in even more peoples being exposed to climate threats.[842] In September 2021, the latest IPCC's report "Climate Change 2021. The Physical Science Basis", confirmed what has already been emphasized in the 2013's report, that it is unequivocal that human activities have warmed the atmosphere, ocean and land, resulting in widespread changes in the atmosphere, ocean, cryosphere and biosphere.[843] Indeed, human-induced climate change is already striking many weather and climate extremes in every region throughout the globe, whereas evidence of ascertained changes include heatwaves, severe precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has been reinforced since 2013'AR5.[844] As a consequence of these impacts, of urbanization processes, and prediction for land subsidence, the exposure to threat of delta cities is projected to increase in the decades to come, whereas significant changes are already in front of us, impacting major delta cities, New York, Bangkok, Manila, and Jakarta.[845] In particular, the Capital of Indonesia, Jakarta, is expected to be moved in a new sustainable and climate-proof area on the island of

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[841] Ibid

[842] Molenaar, A., Aerts, J., Dircke, P., & Ikert, M., (2013) *Connecting Delta Cities III, Resilient cities and climate adaptation strategies*. P. 15, Rotterdam: Programmabureau Klimaat.

[843] IPCC, 2021: Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., Zhai, P., Pirani, A., et al. (eds)]. In Press, p. 4

[844] Ibid, p. 8

[845] Molenaar, A., Aerts, J., Dircke, P., & Ikert, M., *op. cit*., p. 15

Java. The plan to shift the Capital was first announced by President Joko Widodo, announcing the plan back in 2019, in an effort to mitigate the huge environmental burden that Jakarta is bearing, suffering regular flooding.[846] As one of the fastest sinking megacities in the world – also due to the over-extraction of groundwater - parts of north Jakarta are collapsing at an estimated 25 centimeters per year as a consequence of land subsidence, even including the seawall designed as a shield for its communities.[847]

Therefore, the main issue is no longer if delta cities should react in front of risks of flooding but how they should invest in adaptation measures and how to implement them, as shown by the Connecting Delta Cities Network (CDC), launched in 2008 by the City of Rotterdam, where several delta cities joined forces to tackle climate change under the initiative of the C40 Cities Climate Leadership Group.[848] The Connecting Delta Cities (CDC) network was founded in 2008 after the world's leading cities gather in Tokyo for a C40 workshop on climate change adaptation, with Rotterdam taking the initiative to forge and lead this network, and having just launched the ambitious Rotterdam Climate Proof programme, this was a great occasion in sharing experiences and best practices with other delta cities meeting parallel climate-change related challenges.[849] Since its launch, experience has been acquired and shared between delta cities, where the impacts of climate change have become clearer and much progresses has been reached in the development of a climate adaptation strategy, in strengthening resilience, in raising awareness among regional and national government institutions and gaining international recognition.[850]

Michael Bloomberg, former C40 Cities Climate Leadership Group chairman and former New York Mayor, declared "Around the world, city leaders are not wasting time debating the science of climate change or waiting around for international treaties to be signed; we are taking action"[851] while Tokyo developed water discharge tunnels to protect the city particularly exposed to flooding and tropical cyclones.[852] These are just examples showing how delta cities

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[846] Ratcliffe, R., (2022) *Indonesia name new capital Nusantara, replacing sinking Jakarta*, The Guardian [online] Available at: https://www.theguardian.com/world/2022/jan/18/indonesia-names-new-capital-nusantara-replacing-sinking-city-of-jakarta

[847] Ibid

[848] Molenaar, A., Aerts, J., Dircke, P., & Ikert, M., *op. cit*., p. 15

[849] Ivi, p. 21

[850] Ivi, p. 23

[851] Bloomberg, M., (2012) *Bloomberg: Why Sandy forced cities to take lead on climate change*, CNN [online] Available at: https://edition.cnn.com/2013/08/21/world/europe/bloomberg-why-sandy-force-cities/index.html

[852] Zolbert, A., (2012) *How giant tunnels protect Tokyo from flood threat,* CNN [online] Available at: https://edition.cnn.com/2012/10/31/world/asia/japan-flood-tunnel/

acknowledged the importance to act, also helping other cities exposed to climate threats – not only delta areas – to step up. At the present day, city members of the Network are Rotterdam, Copenhagen, Venice, London, Tokyo, Ho Chi Minh City, Shanghai, Jakarta, Honk Kong, Melbourne, New York City, New Orleans, Washington DC, Vancouver, and Rio de Janeiro.

Certainly, the CDC wants to develop an effective way of operating, putting at the core of its agenda widespread documentation supporting the publication of reports, publications and books on climate adaptation in delta cities; the mobilization of experts, projects and proposals related to climate adaptation research and implementation and lastly, share of knowledge, hosting seminars and workshops such as the Deltas in times of Climate Change conference in 2010 organized by the Dutch Knowledge for Climate Programme and the City of Rotterdam in which workshops tailored to policymakers and professional displayed best practices from CDC member cities.[853] Also, in June 2013, the Municipality of Rotterdam hosted the Connecting Delta Cities workshop where Delegates from 23 delta cities experienced Rotterdam's hospitality for four days in order to exchange climate adaptation approaches and consider potential measures, for instance Leah Cohen, Director of Climate Analysis for the City of New York, shares her experience with 2012 Hurricane Sandy and explaining the recovery plan and City's response to climate change, the Mayors' initiative on rebuilding and resiliency; while Beth McLachlan, Senior Sustainability Coordinator for the City of Melbourne, tackled the city's heat and drought periods, water scarcity and wildfires.[854] In the framework of the C40 and the CDC network, strong support and engagement also came from the European Union, funding and launching numerous initiatives in the climate adaptation field. For instance, the RainGain involved the delta cities Rotterdam and London alongside Paris and Leuven with the intention of obtaining elaborated rainfall data at an urban scale to analyze and forecast urban flooding, to exploit the use of rainfall and flood data in urban water management practice in order to make vulnerable municipalities more resilient to water-related events.[855] Another example is given by the Climate-KIC Innovation project Blue Green Dream (2012-2015), led by Imperial College London and involving also the city of Rotterdam and Paris, in which the

[853] Molenaar, A., Aerts, J., Dircke, P., & Ikert, M., *op. cit*., pp. 25-26

[854] Connecting Delta Cities (2013) *Events: Workshop Connecting Delta Cities 2013* [online] Available at: http://deltacityofthefuture.com/events/workshop-connecting-delta-cities-2013

[855] RainGain (n.d.), *Objectives and Actions* [online] Available at: http://www.raingain.eu/en/objectives-and-actions

main purpose is to foster nature-based solutions, in particular enhancing the interaction between green and blue infrastructures in rendering urban areas climate-positive hubs.[856]

Amongst the aspects and characteristics that made Rotterdam a leading delta city and at the head of the C40 Network Connecting Delta Cities, crucial is the attitude of the Municipality in facing major environmental hazards. Despite the threats that Rotterdam faces are not acutely critical, the city promptly engaged in the development of efficient climate-proof actions – Rotterdam Climate Proof – adjusting and adopting the National Delta Programme and implementing local initiatives throughout the cities.[857] In the previous paragraph some of them were mentioned, such as the Floating Pavilion, the development of the ZoHo district and the Benthemplein Watersquare and in this context, other urban actions taking place in Rotterdam are worth mentioning. Alongside the main watercourse crossing the town, the Rooftop Park Rotterdam (the *Dakpark* in dutch) is a multifunctional barrier initiated by the Development Department of the Municipality and its primary purpose is flood defense from the river Meuse but is also functions as retail center and parking lot as they are integrated in the dike and on top of the it, a park is situated for the residents of the neighborhood.[858]

During the development of the projects, residents from surrounding neighborhoods have been actively interested and engaged, suggesting the idea of the retailing function and of the park, pressuring local authorities to get more greenery in the district.[859] In addition, to gather more widespread opinion and address more interest, efforts were put into visiting different locals' groups in the area - e.g. by involving the local mosque – so that residents could engage through all sort of practices, such as formal participation in the project team, evening gatherings in the community center, workshops, information booths where residents could get informed and ask questions, playful activities, sessions with school and with the local mosque, ultimately demonstrating that the municipality created accessibility as regards frequency but also in variety of participation activities.[860] More in detail, the participation process involved the creation of core groups of 4–6 residents taking part in the project management meetings to represent the interests of the community, which sometimes proved to be a difficult task for them as other residents felt that their interests were not represented well enough, leading to the

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[856] Imperial College London (n.d.) *Blue Green Solutions: A Systems Approach to Sustainable, Resilient and Cost-Efficient Urban Development.* Available at: https://www.climate-kic.org/wp-content/uploads/2017/10/BGD-Guide-spread-final.compressed.pdf

[857] Molenaar, A., Aerts, J., Dircke, P., & Ikert, M., *op. cit*., p. 40

[858] Uittenbroek, C. J., et al., (2019) *op. cit.*, p. 2536

[859] Ivi, p. 2537

[860] Ibid

appointment of a professional facilitator, with the task of representing the residents during the project planning and implementation.[861] At the completion of the park residents gathered in a foundation (*Stichting Vrienden Dakpark* - Foundation Friends of Rooftop Park) to organize their participation in the maintenance and oversight of the park, interacting with the gardening company and the city management department[862], showing once again how the interaction between citizens and municipal authorities is valuable to develop environmental-friendly adaptation solutions, in this specific case serving as natural shield against major threats and as recreational public spaces.

In the framework of the Delta Programme, remarkable is the Maasland Barrier, built between 1991 and 1997 in the Nieuwe Waterweg; the structure is entirely automatic and, together with the Hartel Barrier and the expanded Rozenburg dyke, forms the Europoort Barrier, in turn part of the Rotterdam Port. Indeed, protecting Rotterdam and neighboring areas from flooding since 1990s, it was used for the first time in 2007 and the closure of the barrier occur automatically, yet whenever major flooding is expected, an operational team from Rijkswaterstaat is always available to monitor the process and to intervene if necessary.[863]

Fig 4 - The Maersland barrier, Rotterdam (from: Miami Beach Times)

[861] Ibid

[862] Ibid

[863] Ministry of Infrastructure and Water Management (n.d.) *Maeslant Barrier* [online] Available at: https://www.rijkswaterstaat.nl/en/about-us/gems-of-rijkswaterstaat/maeslant-barrier

In densely built-up urban areas, a smart solution is combining urban functions, such as including space for underground water storage on the bottom or on top of car parking garages as has been done at Museum Park and Kruisplein.[864] In the Kruisplein Car Park, additional water storage has been developed on the top of a new parking area near Rotterdam Central Station, and through the use of "Water Shells" a strong light-weight water reservoirs structure has been created adding 2,400 m^3 of additional water storage.[865] The case of the Museum Park also represents the construction of underground water storage (OWB), offering an efficient solution since the edification of extra canals and the installation of separate sewers for rainwater in the area is not possible, as in the case of the Kruisplein Car Park.[866] More specifically, the OWB serves in situations of heavy precipitations since when rainfall is intense, the OWB can be completely loaded in about 30 minutes; then, half of the contents of the sewer system in the center of Rotterdam flow empty into the OWB so that the sewer has enough space to process the rainwater flowing in the streets.[867] The underground water storage is one of the actions developed in the framework of the Waterplan 2. The first Waterplan 1 was launched in 2001, representing a technical elaboration showing how the city could equip itself against torrential rainfalls. Later in 2007, the Waterplan 2 was implemented running from 2007 to 2012, but after this period there was the urgency to update the plan, which was translated in Waterplan 2, with a new vision "Perspective Rotterdam Water City 2030" with the intention of responding to new challenges and developments.[868]

Lastly, a brief description will be dedicated to the Nassahuaven area, where the first floating home (*Havenlofts*) of Rotterdam has been located, built on a site in the eastern part of the city and brought throughout the river Maas to the Nassauhaven.[869] The 18 houses, following the ebb and flow of the river, have solar panels and generate heat through a biomass installation, have their own purification system and they are not connected to the sewage system. Also, until recently the banks of the Nassauhaven were upright and hard with little room for plants and

[864] Molenaar, A., & Gebraad, C., (2014) Rotterdam Resilient Delta City Connecting Water And Adaptation with Opportunities, *Water Governance,* p. 45
[865] Molenaar, A., Aerts, J., Dircke, P., & Ikert, M., *op. cit*., p. 45
[866] Municipality of Rotterdam (n.d.) *Underground Water Storage Museumpark Garage* [online] Available at: https://www.rotterdam.nl/wonen-leven/waterberging-museumparkgarage/
[867] Ibid
[868] Municipality of Rotterdam (n.d.) *(Recalibration) Waterplan 2* [online] Available at: https://www.rotterdam.nl/wonen-leven/waterplan-2/
[869] Municipality of Rotterdam (n.d.) *Harbour lofts and tidal bank in the Nassauhaven* [online] Available at: https://www.rotterdam.nl/wonen-leven/getijdenoever-nassauhaven/

animals, thus the municipality built an environmental sound bank adjacent to the existing Nassauhavenpark, making the living environment green and climate resilient.[870]

In conclusion, it is not a surprise that the Municipality of Rotterdam represents a role model of sustainability and resilience for other delta cities. As many other Dutch cities, Rotterdam has always interacted with water-related perils, yet turning these hazards into great abilities, as demonstrated by its industrial harbor and freight activities and by the timely and prompt response it has developed along with its residents. Its leading role in the Connecting Delta Cities brought exchange of expertise and best practices, interacting directly with cities such as Ho Chi Minh and New Orleans, stimulating adaptation measure where they are needed the most, raising awareness and enhancing cooperation amongst citizens, and lastly, shed light on the severe exposure to climate change of delta cities, yet fostering their prospects to future hazards and opportunities.

2.2 Rotterdam as a floating and green harbor

It should be noted that the city of Rotterdam not only represent a leading delta and coastal city, as its strengths lies also in the greenery that characterize its neighborhoods and public spaces. At the beginning of 2022, after four years from the implementation of the Rotterdam Goes Green Action Programme, the city boasted 21.5 hectares of extra greenery, the equivalent of more than 29 football fields.[871]

Many new green areas can be found throughout the city. Around 200 avenues, squares and parks have been made green and an addition 4.9 hectares are expected to be realized in 2022 and 2023, resulting in a total 12.1 hectares in public spaces. The initiatives to make the city greener also involved numerous residents which actively participated in projects to make the streets or neighborhoods full of green areas; also schools were involved in these initiatives, with the intention to strengthen the presence of the natural environment and reinforcing the idea of coexistence between nature and people.[872] Indeed, in nearly a quarter of all Rotterdam roads, residents were engage in neighborhood greenery in 2021 while of the twelve primary schools that received financial supports for the construction of green-blue friendly schoolyards, six courtyards have now been completed, replacing tiles with greenery and water drainage

[870] Ibid
[871] Municipality of Rotterdam (2022) *Rotterdam 21.5 hectares of greenery* [online] Available at: https://www.rotterdam.nl/wonen-leven/meer-groen-in-de-stad/
[872] Ibid

systems.[873] The city is rich in parks, starting from the Het Park and the Park Schoonoord, the Zuidepark in the southern belt, the Arboretum Trompenburg, the Vroesenpark, the Rhoonse Grienden in the outskirts of the city, the Waterfront along the Nieuwe Maas, ideal for walking and cycling and the Dakpark, which was mentioned earlier, is the biggest rooftop park in Europe, with its 1,200 meters in length and 90 meters in width.[874]

The Municipality has developed over the years a great amount of green areas, green and blue infrastructures, green roofs and facades, the removal of grey surfaces, the planting of trees and brushes along streets and in neighborhoods, contributing to the reduction of the urban carbon footprint and also reducing the impacts of severe climate events, from flooding – since plants and greenery act as natural storage – relieving and mitigating the effects of intense heatwaves and humidity from major watercourses, contribution in the formation of a cooler effect. In 2010, the subsidy programme for green roofs aimed at a strengthened development of a total of 50,000 m^2, the continued installation of green roofs on municipal infrastructures and buildings – for instance, the Maasstad Hospital hosts a wide green roof.[875]

A particular form of green roof is given by the *DakAkker* (Roof Farm) adorning the top of the Schieblock office complex right at the heart of Rotterdam's inner city, measuring 1000 square meters with a height of 20 meters, a true pioneer in urban farming producing vegetables and fruit, flowers and bees, and a wide range of other biological products[876], rendering the city not only resilient from a climate perspective thanks to its permeability to water, but also putting at the core of the municipal agenda the well-being of Rotterdammers, fostering ecological and healthy diets in a system of circular economy. In this respect, remarkable is also the planting of trees, brushes and varieties of greenery on top of Rotterdam's Depot Boijmans Van Beuningen museum, the world's first art storage facility accessible to the public.[877] The tree selected for the museum is the downy birch, a soft birchwood that grows up to ten meters in height and is resistant to the atmospheric condition on the roof; besides the trees are between ten and fifteen years old and have been acclimated to an elevated weather situation over the past years.[878] In addition, the trees are irrigated by a special watering system ensuring that the trees are never

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[873] Ibid
[874] Uittenbroek, C. J., et al., (2019) *op. cit.*, p. 2536
[875] Municipality of Rotterdam (2010) *Rotterdam Climate Proof Programme (RCP)*, p. 17
[876] Rotterdam Resilient (n.d.) *Green Roof Harvests* [online] Available at: https://www.resilientrotterdam.nl/en/initiatives/green-roof-harvests-1
[877] Museum Boijmans Van Beuningen. (n.d.). *Tree planting begins on Depot rooftop garden*. [online] Available at: https://www.boijmans.nl/en/news/Tree-planting-begins-on-Depot-rooftop-garden
[878] Ibid

dry, monitoring will be provided by a specialist arborist, and the majority of these strong specimens are predicted to live for several decades, generating a sustainable landscape where nature, urbanism and art meet.[879]

In the last years, much attention was dedicated to the development and the launch of the first floating farm in Rotterdam. Due to the growth in population and on urbanization processes, land is becoming increasingly scarce – also as a consequence of land subsidence – therefore, by farming in the city, the logistics chain is shortened while pollution is being reduced.[880] 120 floating solar panels – shaped as a milk bottle - are positioned on the water providing electricity; the farm on the water is a transparent construction work divided in three layers; production patterns and sales on the floating city farm are circular and close to citizens.[881] Therefore, any kind of waste is minimized, guaranteeing circularity, sustainability and innovation where a large part of the diet of the farm's cows consists of organic waste flowing from the city, for example by beer bunches from a number of Rotterdam breweries, bran and grain from Schiedam mills, grass from sports fields in the neighborhood.[882] In turn, cow manure is recycled and returned to the Region to be employed in sports fields, golf courses or on rural farms by private individuals; rainwater collected, filtered and then used in the urban farm.[883]

Fig 5 - Floating farm in Rotterdam (from: Miami Beach Times)

[879] Ibid

[880] Resilient Rotterdam (n.d) *Rotterdam is getting world's first floating urban farm* [online] Available at: https://www.resilientrotterdam.nl/en/initiatives/rotterdam-getting-worlds-first-floating-urban-farm

[881] Ibid

[882] Floating Farm (n.d.) *Floating farm* [online] Available at: https://floatingfarm.nl/de-farm

[883] Resilient Rotterdam (n.d) *Rotterdam is getting world's first floating urban farm*

In the Municipality of Rotterdam green spaces are being developed also along the banks of the Nieuwe Waterweg and the Nieuwe Maas, and indeed along these waterflows the Tidal Park was created, in the same district where the first floating houses – Nassauhaven – are located. Dealing with the ebb and flow of the river, in the Tidal Park, the water rises and fall around one and a half meters twice a day due to the strict and open connection to the sea.[884] In fact, because the Nieuwe Maas and the sea meet the port city of Rotterdam, the area is enriched by unique varieties of flora and fauna, being an essential zone for migratory fish - salmon, shellfish and special aquatic plants. This program demonstrates that even with small and local measures, many can be accomplished from creating more natural areas for these spaces, create more natural landscapes available for Rotterdammers and tourists and providing Rotterdam with more natural marine ecosystems and wilderness.[885]

Within the River Banks 2019-2022 programme, more greenery is expected to enrich the Rotte and the Nieuwe Maas, whereas few attractive places have already been added alongside the Rotte, such as the seating and landing deck at the Grotekerkplein and the pier with rental boats on the Lombardkade, the greener Linker Rottekade, with more walking and cycling areas.[886] Also, on the Nieuwe Maas cycling and walking is already possible; the area at BlueCity is being renovated with major greenery additions so that everyone can enjoy the view over the water and the city from a green quay.[887] In the BlueCity district, the municipality along with several partners are planting trees that provide shade as the areas is particularly exposed to extreme heat in the summer, the trees are also heat and drought resistant, they can tolerate salt whenever the river Maas flows onto the quay at high water, even though it is a rare occurrence.[888]

With the intention to expand green areas especially in the inner part of the city, the Municipality, often supported by international stakeholder and by the European Union, develops green resilient initiatives. The Rijkswaterstaat and the municipality want to realize at least 750 square meters of extra floating greenery in the historic inner harbor of Buizengat in

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[884] Municipality of Rotterdam (n.d.) *Program River as tidal park* [online] Available at: https://www.rotterdam.nl/wonen-leven/getijdenpark/

[885] Ibid

[886] Municipality of Rotterdam (n.d.) *Rotterdam is working on attractive riverbanks* [online] Available at: http://www.rotterdam.nl/wonen-leven/programma-rivieroevers/

[887] Ibid

[888] Municipality of Rotterdam (n.d.) *"BlueCity gets a green scarf"* [online] Available at: https://www.rotterdam.nl/wonen-leven/buitenruimte-bluecity/

Kralingen.[889] Amongst the Rijkswaterstaat's most important objective there is the need to develop the floating greenery along the riverbanks and quays to improve water quality, to ensures that rivers and old inland ports - such as Buizengat - become more vivid, natural and attractive again. Indeed, at the beginning of October 2021, a newsletter was sent to residents of the Floating Green area and the purpose is to build the Floating Green between March and June 2022.[890] Lastly, in collaboration with Rijkswaterstaat and the World Wide Fund for Nature, Rotterdam was involved in the EU-funded LIFE programme for the demonstration of two innovative and sustainable projects to combat climate change, the project Urban Adapt experimented in the Zomerhofkwartier district with the adjacent Agniesebuurt and the Nieuwe Maas.[891] For instance, under the Urban Adapt initiative, the plan to replace part of the Heliport's district petrified courtyard with more greenery came from a residents' proposal in 2018 and it was thanks to the collaboration across the community that the new courtyard was rendered greener and climate-proof, more resistant to prolonged, intense rain and extreme heat.[892]

Numerous other initiatives and programs launched to make the city more green, more resilient and sustainable to climate change can be listed and we will always find great interaction between municipal and regional authorities, water boards, private companies and Rotterdammers. These initiatives illustrate the engagement of the city in guaranteeing a greener and cleaner transition toward a resilient Rotterdam, climate-proof and carbon-free and ready to tackle the future challenges. The compelling engagement of citizens, at the frontline when it comes to being involved in the development and launch of climate adaptation initiatives, represent, alongside the rife collaboration amongst public and private stakeholders, one of the key features that are supporting Rotterdam in the transition towards a greener future. Floating buildings – habitations, the first floating farm and the Global Adaptation Center offices – water plazas and water storage facilities, green rooftop, vegetable gardens and green infrastructures, sustainable mobility, dams and water barriers, the international delta port are just some of the milestones that identify the city of Rotterdam, which has repeatedly demonstrated being on the right path towards a climate resilient transition.

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[889] Municipality of Rotterdam (n.d.) *Floating greenery in the Buizengat* [online] Available at: https://www.rotterdam.nl/wonen-leven/buizengat/

[890] Ibid

[891] Urban Adapt (n.d.) *Rotterdam LIFE Urban Adapt works on climate adaptation* [online] Available at: https://urbanadapt.eu

[892] Urban Adapt (n.d.) *Heliport* [online] Available at: https://urbanadapt.eu/project/heliport/

3. Tackling climate change in the Municipality of Amsterdam

As in many Dutch cities, urban development and water management in Amsterdam has been growing side by side for centuries, making the city increasingly resilient to water. However, the city now is forced to face the new pressing challenge of climate change, with impacts and consequences for its residents that become day by day more urgent and intense. The Dutch capital is the most-populous city in the Netherlands, with a temperate marine climate for its proximity to the North Sea with moderately cool summers.[893] In particular, the city is mainly exposed to more intense and frequent precipitations, being the rain a central feature of Amsterdam. Nowadays, extreme rainfall occurs two to five times more frequently than it did in the 1950s, and this trend will persist so that by 2050, it will take place up to five times as often as it does at the present time.[894] In July 2014 a severe and intense rainstorm hit the city, forcing the closure of streets, the cancellation of flights destined for Schiphol, streets were turned into canals and the Waternet water company and the fire department were overwhelmed with emergency calls due to flooded basements, houses, stations, and roads.[895] Of course, the city's sewerage system was unable to handle the considerable amount of water while paved areas lead to less water being able to permeate the soil, increasing the risks of flooding.[896] In fact, due to the characteristic presence of canals, the watercourse crossing the city – IJ River - and the IJmeer lake on the eastern belt of the city, Amsterdam is widely vulnerable to the risk of flooding. Also, the city is exposed to the increase of average temperatures. According to the e Royal Netherlands Meteorological Institute (KNMI) Amsterdam will experience maximum temperatures of 42°C by 2050, with summer of 2018 being the hottest of the last centuries whilst the summer of 2019 recorded the warmest week ever, with parts of the Netherlands reaching temperatures in excess of 40°C, breaking all pre-existing records.[897] Increase in mean temperatures result in damages to water quality and to urban green spaces, more drought periods, such as the 2018 drought which killed young plants and the heatwave of summer 2019 saw 400 more death in the Country than during average hottest week.[898] Therefore, it is imperative for the city of Amsterdam to mitigate the impacts of global warming along with

[893] Klok, L., et. Al., (2019) Assessment of thermally comfortable urban spaces in Amsterdam during hot summer days, *International Journal of Biometeorology*. Vol. 63, p. 130
[894] City of Amsterdam (2020) *Strategy for climate adaptation Amsterdam*, 4 February 2020, p. 8
[895] Ibid
[896] Ivi, p. 45
[897] Ivi, pp. 8, 40
[898] Ivi, pp. 8, 40, 42

adaptation strategies to prepare the city and its dwellers to withstand climate change consequences. In May 2019 the City of Amsterdam Executives approved the administrative instruction on climate adaptation, with the purpose of enacting a coherent and comprehensive urban approach to climate adaptation, complying with the national Delta Plan on Spatial Adaptation. In this regard, the City of Amsterdam, together along the three water boards *Amstel, Gooi en Vecht,* and *Hollands Noorderkwartier en Rijnland* have developed the latest climate adaptation strategy to establish the long-run goal of a climate-proof city.[899]

At the core of Amsterdam's strategy to become climate-resilient, there are the goals of reducing CO_2 emissions by 55 percent in 2030 compared to 1990s levels, to generate 80 percent of households electricity through renewable energies – solar and wind – and reducing by 50 percent the use of raw materials, both within 2030.[900] The long term goal for the Municipality is to become a full climate-neutral city and be completely reliant on a circular-based economy.[901] The Municipality is highly engaged in achieving these objectives, as in the previous years numerous initiatives and municipal plans have been launched to guarantee a resilient transition of the city. The Clean Air Action Plan was drafted in 2019 with the specific aim of improving air quality and expanding the average life expectancy of Amsterdammers by three months in 2030 through the elimination of polluting sources - road traffic, passenger and pleasure crafts, mobile machinery and wood burning – as air pollution represents the third-largest health risk for Amsterdam residents, due to intense concentration of nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$).[902]

The measures enacted by the Action Plan will allow Amsterdam to fulfil the European standards for air quality and to comply by 2030 with the World Health Organization (WHO) guideline for the annual mean concentration rate for fine dusts ($PM_{2.5}$), by which the WHO's (less stringent) recommendation value for PM_{10} will also be satisfied.[903] The approach of the present Plan can be divided in three periods, starting from 2022, in which the objective is to allow in the city center only emission-free buses and coaches; by 2025 all traffic, including taxis, passenger craft and municipal ferries – except for passenger cars and motorbikes, must

[899] Ivi, p. 9
[900] City of Amsterdam (2020) *Policy: Sustainability and Energy* [online] Available at: https://www.amsterdam.nl/en/policy/sustainability/
[901] Ibid
[902] City of Amsterdam (2019) *Clean Air Action Plan*, October 2019, p. 6
[903] Ibid

be zero-emissions within the A10 ring road; lastly, by 2030 all transportation inside the built-up area must be emission-free.[904]

Alongside The Clean Air Action Plan, the Municipality has drafted a detailed roadmap in which the main strategies to accomplish the City's targets and ambitions to halve GHG emissions by 95 percent in 2050. The strategy set out by the Roadmap comprise four transition paths in the field of harbor and industry, electricity, mobility and built environment and for each of these itineraries, several main "pillars" will be delineated describing the modality employed by the city to reduce carbon emissions.[905] Based on the Roadmap for a carbon-free Amsterdam, throughout 2020-2021 numerous concrete accomplishments were made, starting from the number of milliwatt (MW) of solar panels that grew by 70 percent in 2020 (compared to 2019), resulting in 124 MW of solar panels on Amsterdam's rooftops and about half a million solar panels across the city as of 2021.[906] In addition, in 2020 more than 8,000 habitations were connected to a heat distribution grid and the coal-fired power plant on Hemweg was permanently closed, while in 2021 carbon tax for industries was introduced, expected to rise in the upcoming years in order to push industries to adopt sustainable and renewable solutions.[907]

The city of Amsterdam formed a groundbreaking policy network including national policies, visions, agreements, and approaches for the development of circular economy and since 2008, governing political groups in the municipal executive formed a coalition based on green growth and around principles of circularity.[908] The new Amsterdam Circular Strategy 2020-2025 mainly focuses on three value chains, namely food and organic waste flows (fighting food waste and fostering the reuse of organic waste); consumer goods concerning electronics, textiles and furniture that can often be repaired by specialists; and lastly built environment by using sustainable materials.[909] The strategy adopted by Amsterdam is based on British Economist Kate Raworth's Doughnut Economy, whereas the inner ring of the doughnut sets out the minimum required to lead a good life based on the UN's sustainable development goals, while the outer ring of the doughnut represents the ecological cap drawn up by earth-system

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[904] Ivi, p. 12

[905] City of Amsterdam (2020) *Roadmap Amsterdam Neutral 2050*, March 2020, p. 8 [online] Available at: https://www.amsterdam.nl/en/policy/sustainability/policy-climate-neutrality/

[906] City of Amsterdam (2021) *New Amsterdam Climate: Roadmap Amsterdam Neutral 2050*, April 2021, p. 6. [online] Available at: https://www.amsterdam.nl/en/policy/sustainability/policy-climate-neutrality/

[907] Ibid

[908] Savini, F., (2019) The economy that runs on waste: accumulation in the circular city, *Journal of Environmental Policy & Planning*, 21(6), p. 683

[909] City of Amsterdam (2020) *Amsterdam Circular 2020-2025*, pp. 17-18. Available at: https://www.amsterdam.nl/en/policy/sustainability/circular-economy/

specialists highlighting the line which humans should not cross to avoid impairing the climate, soils, oceans, the ozone layer, freshwater and biodiversity.[910] In addition, municipal authorities are developing a monitoring system through which it can be ascertained the social and ecological impact of the circular transition, it can verify whether the city is transitioning toward circular economy identifying areas where improvements need to be done.[911]

In July 2021 the city council adopted the Comprehensive Vision Amsterdam 2050: a humane metropolis describing the ambitious development based on five strategic choices, i.e., polycentric development (from a single city center towards a polycentric urban model, basically becoming a city and a region with more than one urban hub); growth within limits; sustainable and healthy mobility; rigorous greening; and making the city together.[912] In this framework, the Amsterdam Green Infrastructure Vision 2050 has been established with the long-term intention of developing more green infrastructure in order to smoothen the climate-transition of the city. As many other cities across the Netherlands – and worldwide – have done, the strategy aims at fostering green buildings (green façade, green roof, green courtyards, vegetable gardens); community green spaces (streets, squares, in neighborhood parks), park areas (including city parks, sports parks, and allotments), the landscape at the edge of the city, greenways and green-blue connections (such as green streets, watersides and greenways).[913]

Last but not least, the local network Amsterdam Rainproof is an initiative launched by the local water authority Waternet in 2013, supporting the city in becoming a more water-proof and resilient reality after learning lessons from the heavy rainstorm that hit Copenhagen in 2011.[914] The Danish capital was struck by 150 millimeters of rain in only an hour and a half (comparable to two months of rain in the city), and when a simulation instantly indicated that Amsterdam was equally exposed to extreme weather, with some districts having a 45 percent likelihood of impairment during intense precipitations.[915] The Amsterdam Rainproof has the general purpose

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[910] Boffey, D., (2020) *Amsterdam to embrace "doughnut" model to mend post-coronavirus economy*, The Guardian [online] Available at: https://www.theguardian.com/world/2020/apr/08/amsterdam-doughnut-model-mend-post-coronavirus-economy

[911] City of Amsterdam (2015) *Policy: Circular Economy*. [online] Available at: https://www.amsterdam.nl/en/policy/sustainability/circular-economy/

[912] City of Amsterdam (n.d.) *Policy: Urban development.* [online] Available at: https://www.amsterdam.nl/en/policy/urban-development/

[913] City of Amsterdam (2020) *Amsterdam Green Infrastructure Vision 2050 A liveable city for people, plants, and animals*, May 2020, p. 24

[914] Willems, J. J., van Popering-Verkerk, J., & van Eck, L., (2022) How boundary objects facilitate local climate adaptation networks: the cases of Amsterdam Rainproof and Water Sensitive Rotterdam, *Journal of Environmental Planning and Management*, p. 6

[915] Amsterdam Rainproof & Saskia Naafs (n.d.) *Amsterdam Rainproof*. Rainproof Magazine, p. 8. Available at: https://www.rainproof.nl/English

of creating a rainproof city that is organized and designed to absorb and capture rainwater, reducing the likelihood of major flooding and damages.[916] It intends to do so by collaborating not only with municipal authorities, but also with local SMEs, residents, water boards, local and regional organizations and so forth, in order to create a vast network of stakeholder and experts capable of managing every aspect of a weather-resistant Amsterdam. Indeed, the Amsterdam Rainproof intervenes in a wide range of aspects, starting from supporting in making buildings more water-resilient, for instance through green-blue roofs, green facades, or intervening in backing a neighborhood particularly prone to flooding, helping private residents to develop water-friendly gardens by using water-collecting barrels. In conclusion, it can be emphasized that in the last years, the city of Amsterdam accelerated its actions to cope with climate hazards, cooperating with numerous actors and with other cities with the main goal of making climate adaptation as the "new normal", requiring more prompt actions other than current initiatives and plans.[917]

3.1 Green-blue smart solutions in the Dutch capital: the RESILIO project

In 2018, Klok et al. (2019) investigated 21 locations in Amsterdam through the PET (Physiological Equivalent Temperature), showing a reduction in PET of 12 to 22 °C in spaces characterized by shaded areas - by trees and buildings - compared to sun-drenched spots, while it was assessed that water bodies and greenery decreased the PET up to 4 °C maximum compared to impervious zones.[918] The thermal conditions of three types of urban spaces were evaluated, firstly grey locations - impervious areas such as streets and squares – secondly, green locations - green spaces such as parks – and lastly, blue locations - urban areas close to water bodies such as canals, rivers, ponds and fountains.[919] In addition, the variations in the average air temperature, physiological equivalent temperature (PET) over the measurement period (from noon until the late afternoon) and the difference in the thermic experience of the interviewee were taken into account.[920] The results proved that the thermal effect of shading spots is greater, mostly reflected by vast differences in PET of more than 10 °C amongst sunlit and shadowed sites during the hot summer afternoon, while the cooling effect of water bodies in relation to air temperature is limited (less than 1 °C). Therefore, the conclusion that Klok et

[916] Willems, J. J., van Popering-Verkerk, J., & van Eck, L., *op. cit.*, p. 6
[917] City of Amsterdam (2020) *Strategy for climate adaptation Amsterdam*, p. 25
[918] Klok. L., et al., (2019) *op. cit*., p. 129
[919] Ivi, p. 130
[920] Ibid

al. arrived at is that shaded spots have the major cooling effect on the urban environment stressed by the UHI.[921]

In the transition towards a climate-resilient Amsterdam, one of main strategies adopted by the municipality is certainly the use of nature-based adaptation, enhancing green areas and reintegrating natural solutions in the urban sphere, as multiple cities have demonstrated how nature represents the right tool to fight environmental changes. In this regard, blue-green roofs allow cooling and water retention, whilst improving urban biodiversity.[922] The functioning behind the innovation of the green-blue rooftop is that underneath the layer of plants on the roof, extra rainwater is stored; then, through the smart combination of data on weather, water, roof system, and users, water can either be held or discharged in the neighborhood, according to the weather meteorological forecast. Under the leadership of the KWR Water Research Institute, Project Smart Roof 2.0 – in the Mariterrein district - uses highly qualified sensors to measure the precise evaporation and energy balance of the blue-green roof examined.[923]

Cirkel et al., (2018) assessed the benefits of a polder roof employing storage and capillary irrigation systems – the system at the basis of the Smart Roof 2.0 – as much debate arose on the validity of green roofs as adaptation measure because of the insufficient knowledge on evaporation from green roof networks.[924] Cirkel et al. compared the water and energy balancing a traditional green roof with blue-green ones endowed with a storage and capillary irrigation mechanism, demonstrating that conventional green roof systems (i.e., covered by Sedum or herbs and grass) have a minor cooling effect due to a rapid decrease in available moisture and weak evaporation rate while rooftops with a storage and capillary irrigation system revealed a considerably large evaporation rate for Sedum specimen, finally demonstrating that rainwater retentioning and capillary irrigation strongly reduced the number of days with dry-out events.[925]

Following this smart and innovative procedure, the three-year period RESILIO research project (2018-2021) is based on the construction on nearly 10,000 square-meters of blue-green roofs throughout the city of Amsterdam, giving rise to a new type of water management.[926] The technology at the bases of this project proposes to tackle the most urgent climate challenges the city faces, heavy rainfall and the urban heat island effect as a consequence of heatwaves and

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[921] Ivi, pp. 137, 140
[922] City of Amsterdam (2020) *Strategy for climate adaptation Amsterdam*, p. 17
[923] Ibid
[924] Cirkel, D. S., et al., (2018) Evaporation from (Blue-)Green Roofs: Assessing the Benefits of a Storage and Capillary Irrigation System Based on Measurements and Modeling, *Water*, 10(1253), p. 1
[925] Ibid
[926] City of Amsterdam (2020) *Strategy for climate adaptation Amsterdam*, p. 17

increase in mean temperatures maintaining a robust soil water content, fostering building insulation and to regulate local micro-climate.[927] More specifically, four building rooftops covering an area of 8000 square-meters are social housing corporations' units - chosen as they own a considerable percentage of the existing building complex – and 2000 square-meters of roofs on private property buildings both located in areas particularly prone to flooding. The project was conceived as an evolution and an enhanced version of the first blue-green roof, also known as *Polderkak* in Dutch (polder roof).[928] The first green-blue roof was developed at Old School Zuidas at the Gaasterlandstraat, later followed by De Boelelaan and Hotel Casa in southern Amsterdam.[929]

Fig. 6 - The Polderdak Zuidas green-blue rooftop in Amsterdam (©Merlin Michon)

RESILIO represents the perfect model of a multi-layered solution contributing to the city, regional and national policy assistance, for instance supporting the Climate Adaptation City Deal, the National Climate Adaptation Strategy, the Delta Plan for Spatial Adaptation, the Municipal Sewerage Plan 2016-2021, the Vision for Public Space and the cities Green Agenda which proposed to add 50,000 squared-meters of rooftop green areas through subsidy plans.[930] In addition, the local government authority (Municipality of Amsterdam), Waternet - the watercycle company of Amsterdam - experts, building owners, scientific partners and social

[927] Kapetas, L., (2020) the *Resilio project*, Journal no 1 Available at: https://www.uia-initiative.eu/en/news/resilio-journal-developing-network-innovative-and-smart-rooftops-city-amsterdam
[928] Ibid
[929] Rainproof Amsterdam (n.d) *Polder roof* [online] Available at: https://www.rainproof.nl/toolbox/maatregelen/retentiedakpolderdaj
[930] Kapetas, L., (2020) *op. cit.*

engagement professionals are involved in the project, showing once again a great degree of engagement rate.[931] Through RESILIO, Amsterdam takes a step ahead towards turning into a water-resilient city, where the main challenge lies in the "change of paradigm from 'hard grey' to 'blue-green' engineering solutions." [932]

Urban Innovative Actions (UIA) - which supports the project – detected a series of potential implementation challenges that can arise throughout the programme, starting from the appointment of the proper authority guiding the implementation process, the public procurement procedure, the organizational arrangements within the municipal authority, the participatory approach for co-implementation, communication to the beneficiaries and the communities, the monitoring and evaluation process and lastly, the upscaling of the project.[933] These implementation challenges were drafted and shared in early 2020, when there was insufficient data to properly assess them. During the first year after the kick-off of the project, the main activities were being planned, citizen and stakeholder engagement programs were being drawn up, organizational agreements between partners were being prepared and most importantly, roofs were not yet tendered.[934] As of early 2021, the first major challenges addressed had been successfully managed. The procurement of the majority roofs had been carried out, the construction of five out of the eight rooftop polder systems had started, (of which one was already completed), several delays due to problems on the irrigation capillary installation were met in one rooftop – eventually leading to share of knowledge - public engagement was restricted due to the Covid-19.[935]

The project was also expanding an upscale model to transfer and expand the knowledge and experience of RESILIO to other cities and it succeeded in engaging with other UIA-funded projects in Manchester with the IGNITION project, already addressed in Chapter 2 of the present work, Seville with the CartujaQanat, as well as other cities (Graz, Berlin) – although agreements for closer collaborations have not yet been made.[936]

In a short email conversation I had with RESILIO's Assistant Project Manager Joyce Langewen, the project is in the last stage of its implementation, expected to end on 30 April 2022 while in March 2022 will be published the last RESILIO Journal with its results,

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[931] Ibid
[932] Ivi, p. 9
[933] Ivi, p. 7
[934] Kapetas, L., (2021) *RESILIO's Journal #2: From planning to development*, UIA [online] Available at: https://www.uia-initiative.eu/en/news/resilios-journal-2-planning-development-6
[935] Ibid
[936] Ibid

challenges and recommendations.[937] In conclusion, urban roofs in Amsterdam are enriched with green-blue infrastructures which should help reducing the urban heat effect, power consumption at building level, sewerage overflows in times of heavy precipitations and urban flooding, providing at the same time to increased greenery and biodiversity and to the citizen's wellbeing.[938] Most importantly, the project has learned from previous experiences (Old School Zuidas) improving the technology behind the first polder roofs installed in the city, with the prospect to learn from the hindrances occurred throughout the implementation process and to import the benefits of the project in other Dutch cities and worldwide.

The RESILIO project is also possible thanks to the vibrant cooperation that distinguishes numerous initiatives in Dutch cities. This project was supported and developed firstly by the EU-led initiative Urban Innovative Actions – supporting and sharing urban sustainable strategies throughout Europe – which collaborated with the City of Amsterdam, Hogeschool van Amsterdam – research institute – the Rooftop Revolution foundation, Vrije Universiteit, Waternet – a public water management company- several social housing companies and small-medium enterprises.[939] At the European level, the city of Amsterdam is engaged in a numerous projects and initiatives in the attempt to make the municipality water-resilient and climate-proof. For instance, along with the regional authorities of Lombardy, the Burgas Region (Bulgaria), the Twente Region, (Eastern Netherlands), Central Macedonia and Lower Saxony (Germany), the City of Amsterdam represents the western region of the Netherlands in the Interreg Europe-led project RUMORE (Rural-Urban Partnerships Motivating Regional Economies) which has the purpose of strengthening rural-urban cooperation and partnerships also improving regional innovation policies.[940] In this context, the City of Amsterdam envisions to boost the Operational programme of Western Netherlands through projects improving urban-rural market connections, supporting mechanisms for innovation clusters between regions experiencing demographic changes, and plans for enhancing cooperation between the metropolitan areas of Amsterdam, Eindhoven and Rotterdam.[941] Also, in the European Smart Cities Marketplace, the City of Amsterdam along with Grenoble were part of the CITY-ZEN project intending to broaden innovative energy solutions in order to contribute to a sustainable

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[937] Libertini, L., (2022) Email sent to Joyce Langewen - Assistant Project Manager RESILIO, 17 February 2022.
[938] Kapetas, L., (2021) *op. cit.*
[939] Urban Innovative Actions (n.d.) *Amsterdam – RESILIO* [online] Available at: https://www.uia-initiative.eu/en/uia-cities/amsterdam
[940] Interreg Europe (n.d.) *Rural-Urban Partnerships Motivating Regional Economies* [online] Available at: https://www.interregeurope.eu/rumore/
[941] Ibid

energy transition.[942] The main contributions of the city of Amsterdam to the project were made through the objectives of retrofitting existing buildings, to develop smart electricity networks so that habitations will be connected to intelligent grids and the residents will have more control over their energy consumptions, and lastly, improving the heat grid through sustainable heat networks and colling with water.[943] At the international level, the city is also part of numerous global cities networks, starting from the Carbon Neutral Cities Alliance, the Global Covenant of Mayors for Climate and Energy, the C40, where the Green and Healthy Streets Declaration, was signed and is part of the Zero-Emission Vehicles (ZEV) Networks, the Waste to Resources Network and the Urban Flooding Network, just to mention few.[944]

In conclusion, to shape a green and energetic transition by 2050, Amsterdam must be prepared to face all the possible climate scenarios, resorting to step-by-step approaches, closely working with both public and private partners.[945] The engagement of Amsterdammers in activities to make the city more climate-proof is essential, and citizens are at the frontline when it comes to developing new strategies. For instance, the Marineterrein neighborhood and the Laan van Spartaan sports park have been employing naturally cooled synthetic grass pitches where the evaporation of stormwater keeps the artificial field cool even with high temperatures.[946] Also, the Amsterdam Rainproof programme along with the city districts, housing corporations and other partners, is arranging garden campaigns to remove asphalt surfaces from gardens and create more green spaces, in order to allow rainwater to infiltrate the ground more efficiently. Yet, more action is imperative. Making Amsterdam – and all cities - more resilient and climate-proof requires new approaches to urban design and management, more investments in green areas and biodiversity, water preservation, climate-proofing and carbon-free infrastructures, better water and waste management.[947] At the same time, sharing knowledge and best practices will help Amsterdam in managing hindrances and major threats along the way – as shown by the RESILIO projects - in order to guarantee a local and national transition towards sustainable and resilient lifestyles.

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[942] Smart Cities Marketplace (n.d.) *CITY-ZEN Site Amsterdam* [online] Available at: https://smart-cities-marketplace.ec.europa.eu/projects-and-sites/projects/city-zen/city-zen-site-amsterdam

[943] City-Zen (2014) *Amsterdam* [online] Available at: http://www.cityzen-smartcity.eu/home/demonstration-sites/amsterdam/

[944] C40 Cities (n.d.) *Amsterdam* [online] Available at: https://www.c40.org/cities/amsterdam/

[945] City of Amsterdam (2020) *Strategy for climate adaptation Amsterdam*, p. 22

[946] Ivi, p. 17

[947] Ivi, pp. 17, 22

4. Concluding remarks

In this final paragraph, I will report a series of questions and answers that I addressed to the Municipalities of Amsterdam and Rotterdam. In addition, I will draw the final considerations/observations on the relevance of the Dutch case – specifically, of the two cities of Amsterdam and Rotterdam, in the European context, stressing the increasing centrality of the concept of governance in the urban context and recalling the notions of climate adaptation and resilience to try to determine what makes a city resilient to climate change.

As I chose the Dutch cities of Amsterdam and Rotterdam as case studies to explore in the present work, I also wanted/sought to have a different perspective on the actual/real involvement of these cities in coping with global climate change and its impacts. Therefore, I drafted a document of five questions to address/send to the municipalities of Amsterdam and Rotterdam, which in response provided me with prompt and satisfactory replies. The questions were the same for both cities. For the City of Amsterdam, I filled out the contact form I found on the official website of the City, which in turn submitted my questions to the local network Amsterdam Rainproof. For the Municipality of Rotterdam, I directly sent the request to Rotterdam Chief Resilience Officer Mr. Arnoud Moleenar. Having this in mind, I will list the five questions I prepared as I will continue with the replies of Mr. Molenaar concluding with the interview I had with Amsterdam Rainproof Community Manager Ms. Lisette Heijke.

1) What measures have been undertaken by the city of Amsterdam/Rotterdam to raise awareness amongst residents on climate change and climate adaptation?
2) What is the level of engagement/cooperation of the city of Amsterdam/Rotterdam with other municipalities both in the European Union and around the globe to address climate change? What are the main city networks with which the City collaborates?
3) Has the current Covid-19 pandemic affected the City's choices in climate adaptation measures?
4) Presently what are the latest adaptation programs under development expected for the near future?
5) What do you consider to be the strengths and weaknesses of the city of Amsterdam/Rotterdam in the fight against climate change? Where can the City improve?

Concerning the first aspect, the Municipality of Rotterdam was already active in 2005, when during the Rotterdam Architecture Biennale, the main theme was "the Flood", where the theme wanted to demonstrate that the coexistence between architects, engineers, urban planners and

water is possible and can be used as a unique opportunity to realize new landscapes, new buildings and new leisure,[948] as demonstrated for instance by the Water Square in Benthemplein and by the innovative Kruisplein Car Park, with the underground water storage facility to ease the burden of precipitations and flooding to the sewerage system. Mr. Molenaar continued stressing that right after the 2005 Biennale, important policies emerged, starting from the Waterplan2 Rotterdam (2007), the Rotterdam Adaptation Strategy (2013), Resilience strategy (2016) and second Adaptation Strategy (2019); Rotterdam is also a pivotal stakeholder in the Nation Delta Plan. Lastly, he stressed that citizens are being involved in both mitigation and adaptation initiatives and projects, facilitating the so-called "Adaptation Communities."

Regarding the national and international networks in which the Municipality is involved, the present work has highlighted the central role of Rotterdam as the leading city of the C40's Connecting Delta Cities Network and as a member of the Resilient City Network along with The Hague. Indeed, Mr. Molenaar confirmed the centrality of Rotterdam in both the C40 Cities and in the Resilient Cities Network (RCN), in which the Municipality's Mayor Ahmed Aboutaleb became a member of the Board of Directors. Also, the Municipality has been deeply involved with other Delta cities, for instance supporting the recovery of New Orleans and New York after Hurricanes Katrina and Sandy, helping Ho Chi Minh City in developing an efficient adaptation plan, while nowadays, there are collaborations in the climate adaptation field going on with Jakarta, Indonesia and Surat, India. Mr. Molenaar concluded this section by stating that every year, before the outbreak of the Corona pandemic, the City received nearly 75 delegations that wanted to learn from Rotterdam's adaptation experience while in 2019, the city hosted the Resilient Cities Summit, in which 100 delegations of cities were ready to share knowledge and expertise. Lastly, the city has gained even more attention as it is the (floating) headquarter of the Global Center on Adaptation, increasing the exposure of the City's initiatives and work in the field of climate change adaptation.

As of the third question, whether the Covid-19 affected climate adaptation policies, Mr. Molenaar interestingly stressed how the pandemic resulted in "opportunities to accelerate and scale". Indeed, the Municipality launched the so-called "Big7" where seven City districts will receive a boost into becoming more sustainable, green and adaptative to climate change. Continuing with the fourth point, regarding the latest programs expected to be implemented, Mr. Molenaar put the accent on the fact that more and more small- and large-scale measures

[948] Koekebakker, O., (ed.) (2005) *The Flood Catalogue*, International Architecture Biennale Rotterdam (IABR), p. 8. Available at: https://www.iabr.nl/en/editie/the-flood

will be unfolded by Rotterdammers, following the examples set by the present 440.000 square-meters of green roof and by the nine water squares across the city. Lastly, more research is being carried out and possible future scenarios are being explored in the field of climate impacts, especially related to sea level rises.

The last question wanted to explore what the strengths are – that made Rotterdam a leading Delta city – and the weaknesses, from which the City can learn to improve itself. Mr. Molenaar emphasized the fact that Rotterdam succeeded in addressing climate change as a preventive action, and not as a consequence of an environmental disaster, adding that "It's in the DNA of the City; don't talk, but act." At the same time, a weakness is given by the idea that, because the City has always been active in the field of climate change adaptation – almost a pioneer in some actions – then nothing has to be improved. Yet, the underestimating of sea-level rise acceleration patterns forced the City to change its mind, taking a few steps back as this could create a negative image for the Region – and even for the Country – thus, setting the example. Indeed, the present issue will be tackled in the newest Resilience Strategy, right now in development. Lastly, another weakness is given by the fact that funding for adaptation measures and initiatives is continually lacking, an issue that depends on the outcomes of the Municipal elections that will take place in March 2022.[949]

In the case of Amsterdam, a telephone interview has been carried out on 27 January 2022 with Amsterdam Rainproof Community Manager Ms. Lisette Heijke. Starting with the level of awareness amongst Amsterdammers, Ms. Heijke started that there is broad participation amongst citizens on climate change adaptation, where Amsterdam Rainproof covers an important role in spreading more awareness across the community, for instance by sharing reports, infographics, flyers and communication materials on what is climate change adaptation and what people can do to make a difference. In addition, further communication tools are given by active participation and engagement with citizens, by organizing workshops, seminars, initiatives to develop practical solutions on how to introduce more greenery in the citizen's life – to make their habitations and gardens water-resilient. An innovative initiative is given by the Rooftop Festival in which citizens, stakeholders, public and private actors share their experience, knowledge, ideas in order to exploit the potential of rooftops for climate adaptation and sustainable energy needs, contributing to the conservation and restoration of biodiversity,

[949] The information hereby reported was gently provided by Rotterdam Chief Resilience Officer Mr. Arnoud Molenaar.

better air quality, insulation, heat and sound attenuation, and rain collection.[950] Moving to the second question, the City of Amsterdam is certainly very active in multiple regional and international networks, very active in collaborating with the European Union and European cities (such as Copenhagen and Barcelona). In this sense, Amsterdam Rainproof is attempting to create an open regional and international movement, where municipal authorities, private actors, market parties, international and regional organizations can find practical solutions for a water-proof city. Continuing with the third question. Ms. Heijke stressed that the Covid-19 pandemic has certainly hindered a fundamental feature of the City's and the Network's adaptation process, i.e., the level of engagement with citizens. Of course, the normal activities that saw the vast participation of the public were reduced due to the pandemic restrictions, making it difficult to connect, share and work with people.

In the fourth point, addressing adaptation programs under development, Ms. Heijke revealed how the Amsterdam Rainproof is extensively working with housing associations; they are intensifying the mapping of the most vulnerable parts of the cities, the so-called "rainwater bottlenecks", specific parts where rainwater channels can lead to severe flooding in cases of intense precipitations; strengthening underground water storages. Also, the Amsterdam Rainproof was born after the Copenhagen cloudburst of 2011, therefore the network wanted to prevent such a disaster in the Dutch capital. Yet, the Rainproof is broadening its scope, intending to address also more specific climate hazards that hit the cities – drought and heatwaves – especially through green-blue rooftops, rain barrels more greenery in private gardens and throughout buildings. The final questions, on the strengths and weaknesses of the City of Amsterdam, Ms. Heijke pointed out that the City certainly is succeeding in integrating adaptation measures as vital aspects and part of existing policies, stressing the importance that climate adaptation should have in the citizens' routine, showing that Municipality is very active in raising awareness and involving residents. However, the administrative procedures to follow for the implementation of adaptation programs and initiatives often represent the main obstacle, discouraging networks and residents to take initiatives on this subject matter. In addition, financial support is not always granted, rendering the development of programs and pilot projects unfeasible.[951]

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[950] Amsterdam Rainproof (2021) *Festival: ROEF 2021* [online] Available at: https://www.rainproof.nl/agenda/festival-roef-2021. To learn more: https://roefamsterdam.nl/en/

[951] The information hereby reported was gently provided by Amsterdam Rainproof Community Manager Ms. Lisette Heijke.

In conclusion, the chance to have a local perspective on the role and involvement of Amsterdam and Rotterdam on climate actions was enlightening for the purposes of this work, confirming the transparency of the two administrations in their activities, in line with the initiatives and the policies that have been explored in this work. Also, it was significant in shedding a light on the main strengths and weaknesses that characterize the cities, which in turn are conceived as areas where improvements can be made every day, learning from other experiences and mistakes. Central is the role and the participation processes of citizens, at the frontline when it comes to making eco-friendly and resilient choices to improve their city. Certainly, constant action with the support of multi-layered environmental governance is necessary to make urban realities resilient to climate change, and the experience of Amsterdam and Rotterdam shows that despite the difficulties on the road, have chosen the right pact towards a green transition.

To conclude, it is worth mentioning the relevance of the Dutch case in the European framework, with particular focus on the Randstand Holland Region. The Netherlands is a decentralized unitary state, where the territorial decentralization affect the provinces, the municipalities maintain a broad responsibilities, and where functional administrative authorities (e.g., regional water authorities) are responsible for more specific tasks.[952] More generally, urban competences in Dutch cities concern strategic planning, infrastructure, transport and logistics, but also economic development, including tourism, commerce, financial services, employment, renewable energies.[953] In this framework, significant is the Dutch conurbation of the Randstad Holland, including the major cities of Amsterdam, The Hague, Rotterdam and Utrecht, hosting in its territory the port of Rotterdam, first at European level, and one of the largest airports in Europe, the Amsterdam Schiphol, which are flanked by the ports of Ijmuiden, Amsterdam and Dordrecht, and the Rotterdam-Den Haag airport.[954] The Randstad Holland is the most industrialized region in the Netherlands – despite the substantial presence of green areas – with a large infrastructure system counting numerous railways, motorways, tramways and subways and cycling routes, which shape the polycentric urban network that characterize the region, with over 20 cities of more than 70,000 inhabitants each.[955]

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[952] OECD (2014) *Water Governance in the Netherlands: Fit for the Future?* OECD Studied on Water, OECD Publishing, p. 30.

[953] Soriani, S., Calzavara, A., & Pioletti, M., (2019) Riordino territoriale e governance metropolitana. Il caso veneziano nel contesto europeo, Bologna, Pàtron Editore, p. 64.

[954] Ivi, p. 65

[955] Ibid

The Randstad – also known as *Deltametropool* - currently comprise the *Noordvleugel* (which include the conurbations of Haalrem and Ijmuiden in the western area, Amsterdam at the core, Gooi and Utrecht in the eastern part, counting a population of approximately 3.6 million.) and the *Zuidvleugel* (with a population of approximately 3.5 million people where the main conurbation is given by Rotterdam and The Hague, with Delft located between the two cities).[956]

In the specific case of Amsterdam, an important role is covered by the Amsterdam Metropolitan area, known as *Metropoolregio Amsterdam* (MRA), and by the City Region of Amsterdam, *Stradsregio Amsterdam* in Dutch (SRA), which in 1995 replaced the *Regionaal Orgaan Amsterdam* (ROA).[957] Yet, this form of metropolitan organization has always been characterized by numerous weaknesses, as Amsterdam, despite consisting of more than half the population, possessed only one third of SRA's seats; in this sense, the MRA represents the solution to the problem.[958] According to Pasqui & Fedeli (2016), the MRA represents a pattern of regional and voluntary metropolitan governance comprehending 27 municipalities and two provinces, with the comprehensive objectives of producing shared views, coordinating decision-making processes and lobbying the national government.[959] Another significant metropolitan hub is given by the Rotterdam-The Hague area which counts a population of approximately two million and include 24 municipalities, a region with multicentric characteristics and a model of urban governance based on voluntary cooperation.[960]

In 2014, the *Metropoolregio* was established, characterized by the representatives of local municipalities, is a model of urban cooperation and strategic operations, and some of these are worth mentioning. For instance, the construction of the *RandstadtRail*, that is the metropolitan railway linking the metropolitan area of Rotterdam-The Hague; the *Metropoolcard*, a metropolitan card to access a series of services and infrastructures of the Rotterdam-The Hague-Delft area; the Roadmap Next Economy of the Third Industrial Revolution Consulting Group is a wide set of investments and programs, focusing on a wide range of topics, starting from the scarcity of raw materials, climate change, digitalization, new civil and sustainable vehicles.[961] In addition to these programs, a series of green and sustainable strategies such as the Joint

[956] Ivi, p. 66
[957] Ivi, p. 68
[958] Ibid
[959] Pasqui, G & Fedeli, V., (2016) Il ruolo delle «business communities» nei processi costituenti delle aree metropolitane: Uno scenario Europeo. In: Biondi, V., (ed.) *Milano Metropoli Possibile*. Venezia, Marsilio Editori, p. 103
[960] Soriani, S., Calzavara, A., & Pioletti, M., *op. cit.*, p. 70
[961] Ivi, pp. 70-71

Strategies for Green Areas at metropolitan scale, the Economic Business Climate Agenda and the Economic Business Climate Work Program, with the goal of creating new energy infrastructure, improved the attractiveness of the area for national and international investors, the definition of new sustainable development strategies for intra-metropolitan rural areas.[962]

In conclusion, it can be argued that the Dutch case is particularly interesting for the consideration of the formal establishment of metropolitan cities, in relation to the effectiveness of bottom-up approaches of urban governance. In addition the Dutch case is characterized by both the absence of national policies on metropolitan administration and the lack of a regional administration with planning authorities, which ultimately appointed the cities the final decision of cooperating (or not) between entities.[963] The cases of Amsterdam, Rotterdam and The Hague, represent the very heart of a functional metropolitan governance system, where voluntary and horizontal cooperation is fully functional whereas the overall interests of the cities involved are coincidental or, if it is not the case, the municipalities set aside their personal interests in order to achieve the well-being of the whole Region.[964]

[962] Ivi, p. 71
[963] Ibid
[964] Ivi, pp. 65, 72

CONCLUSION

The present work proposed a thorough analysis of the adaptation measures adopted and developed by urban areas in order to become climate resilient centers, highlighting the prominent role that cities are covering in the fight against climate change. Already in the 1960s, scientific evidence was emerging on the perilous impacts that emissions of greenhouse gas emissions had on the environemt. The historical landmarks *Silent Spring* and *Limits to Growth* started to spread awareness on the environmental degradation caused by the unsustainable development and lifestyles adopted by humans, underlining the necessity to reverse this trend before it was too late. Following this path – and based on the work *Only One Earth* – in 1972, the United Nations Stockholm Conference stressed the importance of a global environmental agenda to tackle these issues, later reiterated by the 1992 Rio Earth Summit, where the United Framework Convention on Climate Change was established to acknowledge the urgence to develop timely action to counter the adverse effects of climate change. Further steps were taken during the third Conference of the Parties in 1997, where the Kyoto Protocol was drafted with the primary goal of reducing GHG emissions by five percent compared to 1990s levels in the first commitment period (2008-2012). One of the most important milestones after the Kyoto Protocol, is represented by the Paris Agreement, the result of ten days of negotiations during the COP21 held in Paris in 2015, with the goal of maintaining the global average temperature rise below 2 ºC above pre-industrial levels and limiting the temperature rise to 1,5 ºC above pre-industrial levels. Recognized as a legally binding agreement for its parties, the Paris Agreement presents numerous shortcomings, doubting the effectiveness of this instrument. Its binding aspect was already being questioned in the negotiation process, when the U.S. demanded that emission reduction "should" be undertaken by the parties, rather than "shall." A similar situation occurred throughout the last COP 26, when during the drafting of the Glasgow Climate Pact, India and China pressed for the "phasing-down" of carbon rather than "phasing-out."

Certainly, the milestones mentioned above were significant in setting the basic objectives to address climate-related impacts, in delineating the main actions that the international community shall adopt to mitigate and adapt to the effects of climate change and serving to raise and spread more awareness on the seriousness of global warming. A more direct and timely action is required, as what has been done so far proved to be mostly inefficient. It is in this context that the role of cities emerges as more efficient and targeted, demonstrating that more bottom-up approaches are needed to tackle environmental changes, with the cooperation

of multiple actors, including international organizations, NGOs, businesses, local authorities and the civil community.

Cities represent the major sources of greenhouse gas emissions, despite covering nearly two percent of the Earth's surface. At the same time, megacities, municipalities and small towns are the first target of natural disasters and climate alterations. In the aftermath of the 2005 Hurricane Katrina, New Orleans was completely flooded; New York endured major disruptive consequences when Hurricane Sandy hit the U.S. East-Coast in 2012 while the 2017's hurricane season resulted in storms Irma, Harvey and Maria, amongst the costliest calamities in the U.S. history. In 2021, intense river flooding hit urban areas across Europe, with the most intense casualties and damages recorded by Germany and Belgium; the Netherlands, Italy, Switzerland and Austria were also hit; as a consequence of the heatwave and drought periods of summer 2019 – registered as one of the hottest years in the last decade – major wildfires hit Australia, Siberia, and U.S. particularly the State of California.

It is imperative to adapt and transform urban areas in resilient hubs, ready to tackle the increasing perils of the near future. Throughout this work, the notion of resilience has been explored from the pioneering definition of Crawford S. Holling to the notion delineated by the Intergovernmental Panel on Climate Change, according to which resilience is "The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation."[965] The concept of adaptation – often confused with resilience – is defined as the process of adjusting to present or future hazards. Therefore, what comes to mind is the complementarity that characterize these two aspects, stressing the that one cannot exist without the other, where a system – for the purpose of this work, cities – that is adapted to climate change is resilient. During the elaboration of this thesis, examples of resilient cities were included, in which attention is given to the Brazilian city of Curitiba, where the sustainable development of a widespread system of green areas and the inclusive network of transportation allowed the City to preventively adapt to the effects of climate change.

Afterwards, the thesis highlighted the importance of establishing cooperation and networks with international cities, demonstrating that the exchange of knowledge and best practices is essential in the field of climate change. An important example is given by the Municipality of

[965] IPCC, 2014: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland,

Rotterdam, leading delta city of the Connecting Delta Cities network under the C40 Cities organization, in which Rotterdam shared its know-how on the best practices to live in the vicinity of waterbodies, as a low-lying area that managed to use water as its primary resource. Indeed, in the field of international and regional urban networks, the C40 Cities Climate Leadership Group, the International Council for Local Environmental Activities (ICLEI), the Climate Alliance, the Resilient Cities Network, the United Cities and Local Governments (UCLG), and the Global Covenant of Mayors for Climate and Energy – just to mention the most popular - address a wide range of topics related to urban areas, especially environmental changes and the energetic transition to make urban areas resilient and carbon-free. To facilitate the transition towards more sustainable cities, an important role is covered by the United Nations 2030 Agenda on Sustainable Development, where the goal of making cities and human settlements inclusive, safe, resilient and sustainable is accompanied by other sixteen ambitious objectives.

In the present work, the urgency of a multi-layered system of governance is reflected by the complexity of issues that characterize the sphere of climate change. Thus, it becomes imperative to adopt a holistic approach, in which international organizations, NGOs, private actors and businesses, national and local authorities, the civil community, international and regional networks, work together to reach the final goal of more sustainable and equal cities. The present dissertation has focused its attention on the European urban framework, where the cities of Malmö, Copenhagen, Barcelona, Lisbon, Milan, Turin presented in the third chapter to then conclude with the case of the Netherlands, focusing mainly on the cities of Rotterdam and Amsterdam.

Worth mentioning in the European scenario are the paramount climate initiatives of the European Green Deal and of the European Climate Law, that have the objectives of improving the quality of life of its residents, with actions in a wide range of sectors – environment, transports, agriculture, energy, economy, industry – to reach the ultimate goal of making Europe a green and healthy continent, climate-neutral and carbon-free by 2050. At the urban level, several case studies in the Region of the Baltic Sea (Scandinavian Countries) are explored and also in the Mediterranean area. In the first case, the Cities of Malmö and Copenhagen in the Oresund Strait are demonstrated through the development of innovative and sustainable urban districts, through the construction of houses, common areas, offices, and characterized by the use of ecological and recycled materials, a system of circular economy, the use of green infrastructures and water storage systems, of smart solutions for energy control, of solar panels, ultimately shaping singular areas where sustainability is the key feature. Subsequently, the city

of Milan is featured through the revolutionary Vertical Forest by Architect Stefano Boeri, which became the symbol of urban green sustainability thanks to the restoration of a natural ecosystem – crucial in regulating the urban heat island effect - coexisting with the dynamic landscape of the City. Following the same pathway, the *Nido Verticale* is emerging in the Porta Vittoria district. The Italian city of Turin is presented through the numerous green areas that characterize the city and by the involvement of the Municipality in providing a resilient energy transition, green and recreational spaces accessible for everyone, alternative transportation systems through the development of cycling routes. The innovative website that the City completely dedicated to the energy and climate transition of the municipality, the *Torino Vivibile 2030,* highlights the level of dedication on behalf of the City in fighting the effects of global warming.

What I concluded form the chapter dedicated to the EU, is that the European environmental urban scenario is deeply diversified, a framework in which different cultures, views, and opinions coexist, and is visible from the diversity found in the urban realities of its member states. While it appears evident that the Scandinavian cities are pioneers in the field of climate adaptation and resilience, Mediterranean cities, with Barcelona that boasts amongst the largest tree-lined streets, the green expansion of Turin and Milan, and the Local Urban Environment Adaptation Plan for a Resilient City in Bologna, make it evident that these cities are on the right path, increasing the collaboration with city networks and European cities in numerous pilot projects.

Lastly, more attention has been given to the case of the Netherlands, a country that is almost completely under the sea-level and has developed through the century a singular relationship with water, turning its major threats into opportunities. The Country has developed its first National Delta Programme after the flooding that hit the Netherlands in 1953, resulting in major casualties and damages. The program is based on the so-called Delta Works, a series of engineering operations directed at the construction of water-resistant infrastructures able to protect the Country and its most exposed low-lying areas from major atmospheric events, pluvial flooding, storm surges, sea-level rise, land subsidence and coastal erosion. Emblematic is the Room for the Rivers plan, carried out by the Central Government, regulating the country's waters, its marine and river resources and to control the levels of the Dutch rivers. The Sand-Motors project is based on the extraction of offshore sand to be deposited along the coast by creating a hook-shaped peninsula acting as a natural buffer from major events and using the natural process of sand redistribution. The Delta Programme symbolize a multi-layered and comprehensive approach, where governmental authorities work closely with regional actors and NGOs, businesses, and water boards, and most notably with Dutch people, setting the

example for a winning and comprehensive governance system. The effectiveness of this peculiar model of governance, alongside the decentralized characteristic of the Dutch State, make it possible to address the multiple challenges posed by climate hazards.

Entering more in detail, the case study of Rotterdam revealed a dynamic, ground-breaking, and open reality, where a wide number of innovations are making the city a truly sustainable hub. Throughout this section, I presented some of the main initiatives and plans undertaken by the Municipality in addressing environmental impacts, starting by defining the important progresses that Rotterdam is making as a port city, expanding projects that could help the reduction of GHG emissions generated by the harbor and industrial activities. The main focus in the case of Rotterdam was the role as delta leading city in the Connecting Delta Cities network under the C40. With its experiences as a delta city – located in the delta of the Rhine-Maas-Scheldt rivers – Rotterdam has created a long-lasting cooperation with international coastal and delta cities, - New Orleans, Tokyo, Ho Chi Minh, and many others - supporting them in developing efficient climate adaptation programs based on its own experience. Attention during the paragraph, has also been given to the pioneering innovations of the floating Pavilion, the floating houses and the first floating farm where the key aspects are sustainability and circular economy.

In the case of Amsterdam, I addressed the main policies - Amsterdam Climate Neutral, the Amsterdam Circular 2020-2025 Strategy, the Clean Air Action Plan - launched by the Municipality with the broader objective of becoming emissions-free by 2050, contributing to the major EU target set out by the EU Climate Law. More prominence has been given to the RESILIO project where green-blue rooftops have the broader scope of acting as natural buffers to mitigate the climate effects in the city. The project – supported by the EU initiative Urban Innovative Actions program – is based on the concept of polder roofs, where green-blue infrastructures are developed on the city rooftops of both private and public buildings, in a smart mechanism according to which rainwater is retained in a system of water storage that will be used to irrigate the plants, trees, and vegetation installed in the roofs, to reduce the pressure on the sewage system when heavy precipitations occur in the city, and to mitigate the common urban heat island effect that characterizes the city during the hot season.

Finally, the last paragraph reported the interviews I personally had with two representatives of the municipalities of Rotterdam and Amsterdam, to be more precise with Rotterdam Chief Resilience Officer Arnoud Molenaar and Amsterdam Rainproof Community Manager Lisette Heijke. The insights provided by the two interviews allowed me to understand that what the two cities cherish the most is the development of resilient and sustainable areas where residents

can live a healthy live and where a strong sense of community is at the basis of climate initiatives. At the same time, it was possible to acknowledge that the cooperation with multiple actors, stemming from regional water boards, NGOs, local and international networks of cities, the civil community, private businesses, the academia and many more, is at the very core of the innovation and sustainability that distinguish these two cities, resulting in a widespread set of winning solutions.

I feel to conclude this dissertation by stating that, especially in view of the recent COP26 held in Glasgow, what emerges is the urgency with which the challenge of climate change must be tackled. States - especially industrialized ones - international and regional organizations, NGOs, businesses, cities and the civil society, are the protagonists in the struggle against the extreme impacts of global warming. However, the actions adopted so far are not deemed to be sufficient. The present work strengthened and demonstrated that amongst the many actors listed above, cities can take a significant step forward in the fight against climate change, as they are increasingly engaged in numerous international and regional networks, strengthening cooperation with multiple actors and municipalities, creating a multi-layered and inclusive system of environmental and urban governance. The active role and participation of cities *can* save the planet, proving that victory against climate change is possible.

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