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ARTICLE

The Role of Urban Services, Climate Services and Insurance Services in Urban Climate Change Adaptation Processes

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ABSTRACT

The increasing frequency and magnitude of extreme events associated with climate change represent a pressing issue on a global and local scale. While waiting for the desirable effects of mitigation measures, the scientific community, governments, and private businesses should increase their commitment to adaptation as a transition strategy. As a response to emerging risks, the adoption of non-structural (or "soft") adaptation solutions—which concerns the organizational and intangible aspects of systems—represents a valid and complementary option to infrastructural ("hard") interventions in contexts of high uncertainty. In line with this approach, the paper reports the results of ongoing research on the strategic role of Urban Facility Management (UFM) services in supporting cities in the adaptation process to climate change effects. It also highlights the potential contribution of insurance brokers and investigates competencies, responsibilities, and information flows in Urban service processes. The results of this analysis converge in a proposal for re-designed service delivery models that meet emerging needs and make the integration between urban, climate, and insurance services operative to achieve an innovative "Adaptation services" system. The hypotheses and the proposals are tested by observing a case study—an Italian medium-sized municipality—where implementing Adaptation services models triggers new relationships between public and private stakeholders and forms of collaboration with insurance suppliers.

Keywords: Climate change; Adaptation; Soft-resilience; Urban services; Urban Facility Management; Insurance

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1. Introduction

The increasing frequency and magnitude of extreme events associated with climate change represent a pressing issue on a global and local scale[1]. While waiting for the desirable effects of mitigation measures, the scientific community, governments, and private businesses should increase their commitment to adaptation in the short and medium term as a transition strategy.

The study takes the moves from the identification of three main barriers to built environment adaptation to climate change that lead to deadlocks and inaction: i) the uncertainty characterizing climate change effects and impacts and the projections on the phenomenon evolution; ii) the high complexity of human systems; iii) the lack of tools to carry out rigorous assessments of adaptation measures effectiveness.

From this analysis comes the idea of the need to adopt a new approach to the issue of climate change adaptation, which requires deepening the distinction between hard and soft strategies. The soft approach - which concerns the organizational and intangible aspects of systems - in contexts of high uncertainty is a valid alternative in response to emerging risks, complementary to structural interventions (hard).

Soft solutions, thanks to the intrinsic characteristics of flexibility, reversibility, adaptability, scalability, compatibility with other measures and cost-effectiveness, may be regarded as low-regret solutions or "measures that would generate net social and/or economic benefits both under current climate and a range of future climate change scenarios"[2]. Furthermore, the UK Adaptation Sub-Committee defines soft adaptation solutions as "adaptive measures for which the associated costs are relatively low and for which the benefits, although primarily realised under projected future climate changes, may be relatively large", hence referring to the co-benefits arising from their implementation.

This paper hypothesizes that reorganizing urban services for climate change adaptation inherently constitutes a soft, low-regret strategy with significant co-benefits. Furthermore, insurance providers can play a crucial role in supporting local governments in this process.

2. The contribution of the urban services sector in urban adaptation processes and the central role of Urban Facility Management services

Dealing with organizational, soft climate adaptation strategies in cities leads to exploring urban governance and the array of services for human systems or services needed to support urban management. These are urban services.

The urban services sector is identified as an essential contributor to urban adaptation in a relevant report on sustainable finance published in 2020 by the European Commission: it provides a taxonomy setting performance screening criteria for economic activities that "make a substantive contribution to one of six environmental objectives and do no significant harm to the other five"[3]. Climate change adaptation is the second of the six environmental objectives identified straight after mitigation.

The World Economic Forum (2016) claims that "the level of development of a city directly influences the quantity and the quality of available urban services"[4]. However, the opposite is also true: it is easy to agree with the United States Agency for International Development saying that "strengthening the effective and equitable delivery of services would promote economic growth, poverty reduction and contribute to security". Better-managed cities with improved services are generally more resilient.

Existing approaches to urban resilience, like the one adopted by the Rockefeller Foundation in its ambitious project 100 Resilient Cities or by ONU-Habitat's New Urban Agenda and many others, distinguish different subclasses of urban services. However, a standardized classification is not available yet[5]. There are neither universally accepted and shared definitions of urban services categories nor a clear delineation of different interlinked types of services. Given the emergence of the urban services sector as a critical contributor to adaptation processes, further insights are needed.

The proposal of a new terminology able to shed light on the role of urban services is an essential step in this investigation. It represents a valuable contribution to scientific literature related to urban studies and climate change management.

This paper suggests a functional classification of urban services from the perspective of adaptation to climate change, which distinguishes three different classes: i) Municipal services, ii) Urban Facility Management services, and iii) Emergency services.

i) Municipal services include all those services "provided in the context of city management, including transportation, housing, water management, waste management, snow clearance, etc."[6]. They can be provided directly by local governments, by public agencies or by contracting private suppliers. This class of services includes, but is not limited to: education services; public health and healthcare services; public safety services; environment protection services; mobility and transportation services; energy supply services; water supply services; telecommunication services; urban planning; public works; social services; natural resources governance services.
ii) Urban Facility Management services (UFMs) is an extension of the concept of Facility Management, a "management function, which integrates people, place and process within the built environment to improve the quality of life of people and the productivity of the core business"[7]. This definition includes all the supporting services that contribute to the achievement of the core objectives of an organization. Enhancing sustainability, resilience and adaptation to climate change undoubtedly falls within any organisation's core objectives. This aspect assumes primary importance in light of the rising magnitude and frequency of climate hazards due to anthropogenic climate change. Hence, if the envisaged "organization" is a local government, then the city is the object of facility management services – Michell's proposal of the "city-is-the-facility" view – and this leads to scale and extend Facility Management principles and practices to the challenge of delivering services on an urban or community scale. Consistently, UFM services are defined as the "integrated management services for the operation, the serviceability and the valorization of urban facilities"[8].

As indicated in the UNI:11447 (2012), the services oriented to the management of urban facilities may be distinguished into: services for the territory (monitoring and maintenance of urban green, plants, road network and others); services for buildings, plants, infra-structures (monitoring and maintenance of water systems, sewers, infrastructure for public transport, security technology installations, telephone and data transmission networks, availability and emergency intervention and others); services for the environment and the community (cleaning and environmental hygiene, waste collection and disposal, space management and others); government services (technical and inventory registers, implementation and management of information systems, operational centres and others).

In 2013, Jaewook et al.[9] highlighted the need to adopt an integrated approach to "intelligent" urban facilities management to enable real-time emergency response. More in particular, the proposal provides for the integration of facilities-related information with management functions. However, the contribution needs to go more in-depth into the scenarios concerned with climate change. Alenka et al.[10] envisaged a "more proactive role for Facility Management in the urban context", oriented to respond to social and economic challenges through modified management forms. However, climate change deserves a vague mention. Boyle and Michell[11] claimed that urban sustainability needs to draw upon the principles of Facility Management; this would facilitate more comprehensive development and assessment relevant to the specific needs of local governments, adopting a "process-oriented method"[11].

According to Pearce[12], sustainable urban facilities management is the "set of actions and decisions pertaining to the built environment that have the net effect of increasing the sustainability and resilience of human enterprise". The fundamental ideas of Facility Management can be scaled to more significant developments and human communities, which leads to sustainable UFMs. Hence, UFMs must play multiple roles to "translate the strategic goals of an organization or community into a physical environment where those goals can be achieved, then support the effective and safe operation of that environment"[12]. More agile processes for Urban Facility Management services delivery would enable a better response to human systems' needs. This would require further evolutions of both processes and technologies.

Moretti et al.[13] supported this view by looking at Urban Facility Management as an "extension" of the concept of Facility Management and outlining the co-benefits of an improvement in the quality of these services: UFM service not only enables the operation but also would enhance the

fruition and valorisation of urban goods, restoring the performance of assets at a proper level of quality, providing a suitable environment for human beings, within the sustainability framework.

iii) Emergency services are usually supplied by the Public Administration and aim to provide immediate and quick responses to extreme events and emergencies when they occur. A fundamental distinction is made between primary and secondary emergency services [14]. Primary emergency services include: police; fire and rescue services; Emergency Medical Services (EMS); and the Coast Guard. Secondary emergency services include: military; incident response teams; emergency management; community service; Civil Protection; emergency social services; and emergency road services.

Among these three classes of urban services, Urban Facility Management services are particularly interesting from the climate change adaptation perspective. Once assumed that climate change leads to significant and uncertain changes in statistics on the frequency and magnitude of climate phenomena, re-calibrating UFM services delivery models based on updated data and information cannot be avoided. This implies re-designing the contractual terms regulating the relationships between UFM users and suppliers.

Presently, emergency services – and secondary ones in particular, such as Civil Protection, emergency management and emergency road services – often compensate for the inadequacy of contractual forms that regulate the delivery of UFMs. A simple example regards falling trees due to windstorms: if the terms of contracts with UFM suppliers do not provide for a first-aid public greenery maintenance service, then fire and rescue services or Civil Protection are called to intervene to burden and clear the area. However, these services are not equipped with specific competences and tools (chainsaws, trucks to transport tree trunks and others) to optimally perform this task.

The design of new models for implementing Urban Facility Management services is proposed here as an effective soft-approach, low-regret and co-benefit climate adaptation strategy.

3. The information basis for adaptation: climate services and the transition towards an integrated system of adaptation services

Specific and detailed information is needed to reorganize, re-calibrate, and re-design Urban Facility Management services delivery models as a strategy to tackle climate change impacts. This would lead to a switch from non-climate-informed urban services to so-called Integrated Urban services [15]. The World Meteorological Organization (WMO) suggests that "integrated urban services should assist cities to cope with challenges through making good use of dense observation networks, high-resolution forecasts across different time scales, multi-hazard early warning systems and climate services for risk management and adaptation strategies". The grade of integration of climate information in human systems management processes still needs to be improved, and despite the growing availability of climate data, a lack of actionable information can still be observed. Information may require tailoring, interpretation or integration with other information before it is revealed to be beneficial [16].

This fundamental information basis takes the name of **"**climate services". They are seen by the World Meteorological Organization (WMO) as **"**highly spatially resolved information on an urban scale of weather and climate [⋯] that supports the decision-making processes required for the provisions of the general urban services" [15].

The current definition of climate services provided by the Global Framework for Climate Services (GFCS) is: "climate information in a way that assists decision-making by individuals and organizations. A service requires appropriate engagement and an effective access mechanism and must respond to user needs".

According to the National Research Council, climate services are the "timely production and delivery of useful climate data and knowledge to decision-makers".

The Joint Programme Initiative (JPI-Climate) defines climate services as "user-driven development and provision of knowledge for understanding the climate, climate change and its impacts, as well as guidance in its use to researchers and decision-makers in policy and business".

The European Commission identifies in climate services the "transformation of climate-related data and other

relevant information into customized products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessments), counselling on best practices, development and evaluation of solution, and other services about climate that may be of use for society at large"[17]. It introduces the possibility of integrating climate-related information with other relevant information from different sources.

Kathleen[16] broadly conceptualizes the developments of climate services as "climate knowledge systems", stressing the importance of the three-phase transformation "DIK" from Data to usable Information up to Knowledge.

This study resulted in an extremely useful interpretation of a definition provided by the Climate Technology Centre and Network (CTCN) in which the emerging idea of a new, innovative set of climate services is well represented by the following adapted definition: any service, equipment, techniques, practical knowledge and skills that can be used to increase climate resilience of the human system.

Available definitions of climate services are pretty broad. Many different products or services may fall within this category, including many products still need to be clearly identified as climate services. This makes it very difficult to get an overview of the state of the art of climate services in Europe and worldwide. It also affects a complete analysis of potential gaps between offered services and users' requirements.

Many climate service differentiations have already been applied. Climate services are presently distinguished by: sector; data sources; time horizon of interest; the purpose of use (for research, policy-making or decision-making); level of processing of the data (primary climate data or data processed into products such as maps, impacts, decisions); level of background knowledge of the intended user (basic or advanced users)[18].

The differentiation of climate services by time horizon is the one that best fits the purpose of this paper.

Climate services may concern i) past climate: data stewardship and rescue, reanalysis and historical climate summaries; ii) present climate: observations, monitoring, climate summaries, reports, and studies, to estimate the type, range, and likelihood of variations of climate variables relevant to planning and applications at national, state, and local levels[19]; and iii) future climate: forecasts and projections of climate conditions, climate models (Global Climate Models (GCMs), National Climate Models (NCMs), Regional Climate Models (RCMs), Local Climate Models (LCMs) and Sub-local climate models)[2].

Climate services concerning future climate can be further classified as short, medium or long-term. The American Meteorology Society (AMS) distinguishes climate services by periods ranging from days (climate-related extreme events) to decades.

When dealing with urban adaptation planning and implementation, the time horizons to be considered are the real-time, short and medium-term, since adaptation is a transition strategy. The long-term regards mitigation, since the effects of any mitigation action undertaken are generally only appreciable in the long term, after decades[20].

Similarly, the spatial scale of adaptation is local, while mitigation must deal with the global scale. Gupta et al.[21] observed that "climate change is a "glocal" phenomenon", which would require to "think global but act local".

Despite the evidence of these claims, weather warnings (real-time), forecasts (short-term) and medium-term climate projections are often provided at the regional scale and adjusted through statistical estimations at the local one. Climate change scenarios are often derived from Global Climate Models (GCMs) or National Climate Models (NCMs) and "downscaled" to acquire information on the local and even the sub-local level, even though they have no such grade of detail. All this entails a big gap between climate change models and the local experience at the city or even at the neighbourhood level.

Another issue regards the implementability of climate information: climate services show limitations in their effectiveness when delivering usable information for the implementation of adaptation measures. Making climate information applicable may require tailoring, interpretation, and integration with other information. Due to their complexity, a figure that "bridges the gap" between scientific information products (models, projections etc.) and the final users is needed. This figure should "translate" the climate information into usable information for decision-making at the different spatial and temporal scales, transforming information into tailored informative products. Thus, the need for an "intermediary" or dedicated, specialized consulting services for adaptation emerges. Similar concepts are ex-

pressed by some relevant institutions like the Climate Service Center Germany (GERICS). GERICS proposes a view of cities as complex networks with very specific framework conditions, which means that no "one-size-fits-all" solutions for adaptation can be successfully implemented. The idea is "to link local climate information with other information"[22] to provide innovative support to cities in their adaptation process.

In pursuance of these considerations, an integration between climate services (weather warnings, forecasts and short and medium-term climate projections) and Urban Facility Management services and emergency services should be envisaged. This integrated environment of services could earn the name of "Adaptation services".

The terminology "Adaptation services" has already been used by some institutions committed to climate change adaptation, with different meanings: the European Environment Agency employed the terminology "Adaptation services" to identify services aimed at "increasing the capacity of society, cities and infrastructure to be able to adapt to climate change — taking knowledge from climate services and translating it into concrete services and solutions [⋯]"[23]. This broad definition is adopted by the Climate-KIC community also. The Netherland's based CAS Foundation (Climate Adaptation Services) considers Adaptation services as "information services supporting the assessment of vulnerability from a wider perspective, and includes design and appraisal of adaptation strategies, going the last mile by translating climate impact information to policy-relevant and usable science".

The activation of Adaptation services would give back huge benefits regardless of the climate conditions, not only in terms of adaptation but also in terms of management efficiency, cost reduction and urban comfort, hence complying with the definition of co-benefits and low-regret adaptation measures.

4. Insurance positioning in the integrated environment of adaptation services: the need for innovative adaptation consulting services

In light of these premises, the following research question emerged as a key focus: where are insurance services positioned within this context?

Before deepening the role that insurance could play in adaptation processes, it should be better specified what types of insurance services should be examined in this light.

Two leading figures operating as insurance services suppliers can be distinguished: i) insurance companies; and ii) insurance brokerage companies.

Insurance companies represent the seller. They authorize agents ("captive" agents engaged by only one seller or "independent" agents working with multiple sellers) to enter into agreements on their behalf. Insurance companies offer clients insurance policies in which they agree to take certain pre-defined types of risk on behalf of the insurer while excluding other types.

Insurance brokers, on the other hand, represent the buying side. This means that brokers are chosen and paid by buyers of insurance. Brokers are usually huge corporations and buy insurance in bulk; they have a lot of trading power, so they can negotiate with insurance companies to obtain lower prices.

The function of the first category – insurance companies – is, basically, to compensate for losses[17]. It can be stated that compensation is an "ex-post" intervention.

The meaning of adaptation refers to the concepts of prevention, damage minimization and risk mitigation. Considering that risk is the product of hazard and vulnerability[24], it is intuitive to understand that adapting to emerging risks in the short/medium term involves acting on the vulnerability of systems since any action aimed at reducing the magnitude of the hazard (climate change mitigation) requires decades[20].

According to this logic, insurance policies should be updated by including in the evaluations the complex issues connected with climate change adaptation, hence responding to new insurance coverage needs. However, they cannot be considered as adaptation tools in pursuance of their compensating, ex-post function.

Reducing the impacts of climate change effects requires instead ex-ante interventions.

Thus, figure of insurance brokers has much more potential relevance than insurance companies in the context of built environment adaptation to climate change. Given the focus of this paper on urban adaptation processes, brokerage companies' services for public entities – and, in particular, local governments – will be deepened.

Traditionally, brokers offer to public administrations the following specialized services: risk assessment and exposure analysis; coverage analysis, program design and program placement; strategic market advocacy; preparation of new cover; consultancy in preparing the call for tenders; claims management; portfolio management; actuarial and analytics; alternative risk financing; risk control and claims consulting; total cost of risk analysis techniques; risk management consulting; crisis management, disaster recovery and contingency planning; and others. Climate risks must be considered to provide valuable services and accurate and up-to-date consultancy.

From an in-depth analysis of the largest international brokerage companies' offer of services for public entities and from stakeholders' consultation it results that, besides these "traditional" functions and services, insurance brokers are increasingly required to provide some innovative consulting services related to emerging risks connected with climate change in their public sector practice. Such innovative services would fall within the definition of "Adaptation services" proposed above, referring to services that increase the adaptive capacity of cities by drawing knowledge from climate services and translating it into concrete solutions.

These would be, therefore, configured as specialized, tailored and dedicated consulting services aimed at identifying viable adaptation solutions, hence clinching the definition of "Adaptation consulting services".

Adaptation consulting services would facilitate local governments, especially in four tasks:

1) the identification and reading of specific climate risks and consequent adaptation needs;
2) the "translation" of climate services into usable climate information tailored to specific needs;
3) the design of adaptation measures in response to the identified adaptation needs;
4) the evaluation of the effectiveness of adaptation measures.

Based on the point of view proposed in the previous paragraphs of this contribution, the following hypotheses are put forward:

1) specific adaptation needs can be deduced through an in-depth insurance coverage analysis, looking at insurance policies – in the case of public entities, the civil liability cover to third parties (RCT) – terms, expenses in insurance deductible, data on losses, data on claims;
2) valuable and usable climate information dealing with adaptation in general and in this particular operational context corresponds to localized, high-resolution, short to medium-term climate information;
3) viable and effective adaptation measures should be based on tailored climate services, should be co-developed by local governments and insurance brokers, and should respond to the following characteristics: soft approach, low-regret, and co-benefits. They should imply the re-design of specific Urban Facility Management services delivery models by re-drafting contract terms with UFMs suppliers. This is suggested as an effective impact-mitigation strategy;
4) the evaluation of the adopted and implemented adaptation measures should be based on the comparative analysis of i) previous and actual insurance policy terms; ii) expenses in insurance deductible; iii) data on losses; and iv) data on RCT claims connected with climate change phenomena. The evolution of these factors should be tracked since they could be assumed as indicators of the effectiveness of some adaptation measures. Insurance contracts usually have a duration of 3 years, so evaluations can be conducted with the same frequency.

Providing such innovative Adaptation consulting services requires an extremely high integration level of climate services into the different services supply processes and interpolating other heterogeneous data.

Insurances rely on historical loss and exposure data [25], but the fact is that risk dynamics related to climate change are constantly changing, so insurance services suppliers should update the already-known trends and take into consideration future trending variables. Past observations and present and likely future developments must be integrated to improve the basis of investment decision-making.

One of the main criticalities concerning this topic is the reluctance of insurance companies to share data since it constitutes a great company asset and is part of the specific know-how of a given firm.

Hence, insurance-related information management is strongly affected by this hindrance. This is a barrier concerning data management policies, so it is beyond this study's scope. In **Figure 1**, a centralized database on losses and

claims is hypothesized, as well as an accessible information system.

Figure 1 represents the complex system of relationships and the information flows between urban adaptation processes and stakeholders. Insurance brokers assume a central role as a "link" between climate services suppliers and public entities (local governments) while integrating climate information and data on losses and claims.

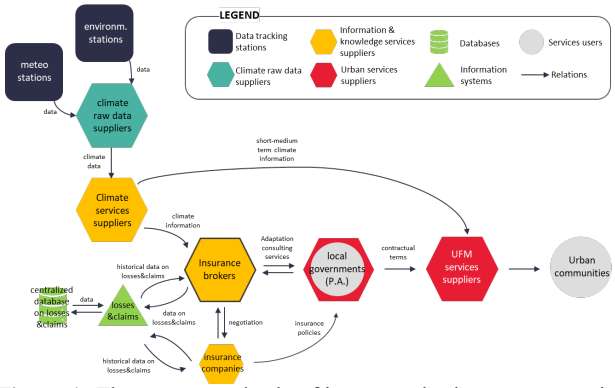

Figure 1. The new central role of insurance brokerage companies in the system of relationships between urban adaptation processes stakeholders.

Adaptation consulting services supply could be seen as the highest step of the DIK (Data, Information, Knowledge) pyramid: meteorological and environmental observations and historical data are transferred to climate raw data suppliers; then, they are elaborated and transformed into climate information (climate services) by climate services suppliers; the interpolation between climate information, data owned by insurances and other heterogeneous data on urban processes (Urban Facility Management processes) would produce knowledge on climate impacts; this knowledge can be transferred to stakeholders (local governments, urban services suppliers and citizens) and used to design and implement tailored, viable adaptation solutions relying on urban services reorganizational strategies. This would mean supplying Adaptation consulting services.

In pursuance of all these considerations and in line with the view proposed in this paper, the assumption of a central role in urban adaptation processes by insurance brokerage companies and their desirable ex-ante intervention – supporting local governments in the re-design of specific Urban Facility Management services delivery models through the re-drafting of contract terms – would constitute by itself a soft-approach adaptation measure. Furthermore, it can be defined as a low-regret measure since it requires relatively small investments and gives back co-benefits, besides climate change impacts reduction: savings in annual expenses on insurance policies and deductibles and higher urban comfort.

Insurance services and Urban Facility Management suppliers must, therefore, take on the new challenges and adopt new approaches and tools to tackle climate change emerging risks.

5. Reality check: methodology

In the previous paragraph, four hypotheses were advanced on i) the convenience of analyzing the terms of civil liability cover to third parties (RCT) of a particular local government, the expenses in insurance deductible, the data on losses and the data on claims to identify adaptation needs; ii) the need for local governments to acquire localized, high-resolution, short to medium-term climate services to have solid information based on which iii) implementing the re-design of Urban Facility Management services delivery models in close collaboration with insurance brokers as a soft-approach adaptation measure; iv) the possibility to take, as indicators of the effectiveness of adaptation measures, the improvements in municipal insurance policies terms, besides the reductions in losses and related costs.

The hypotheses were tested in a real case study involving a medium-sized municipality in northern Italy that was impacted by strong winds and falling trees.

In the presented case study, the reorganization of Urban Facility Management services through the re-writing of contract specifications provided greater flexibility and efficiency in operations. The new contracts triggered a transition and open up the possibility of enhancing urban maintenance services in the perspective of climate adaptation (Adaptation services) and of integrating new information sets and new figures (Adaptation consulting services and insurance brokers) into adaptation processes.

The methodology applied included a thorough analysis of selected municipal documents related to 8 years (from 2014 to 2021) and a continuous dialogue with key stakeholders – municipal officers and technicians, UFMs and emergency services suppliers, and insurance brokers – through semi-structured interviews.

An in-depth analysis of all the municipal documents and contracts that could relate to the management of windstorms

and falling trees was carried out to identify key elements and factors of innovation in the direction of increased adaptability.

The documents selected for this analysis were:

i) the invitation to tender for the acquisition of road maintenance services;
ii) the contracts with road maintenance services suppliers;
iii) the invitation to tender for the acquisition of public greenery maintenance services;
iv) the contracts with public greenery maintenance services suppliers;
v) the invitation to tender for the acquisition of insurance services (RCT);
vi) the insurance claims statistics (RCT);
vii) the proposed modifications to the technical offers advanced by the local government;
viii) the RCT municipal insurance policies.

6. Effectiveness of Urban Facility Management services delivery models re-design in an Italian case study

The case study is a Municipality of the Metropolitan City of Milano (in northern Italy) of about 30'000 inhabitants. The observed Municipality has recorded in the last years (from 2014 to 2021) a significant increase in the phenomena of strong winds and consequent fall of trees. The increase in magnitude and frequency of windstorms is included among the main effects of climate change on cities listed in the Fifth IPCC Assessment Report[2]. The fall of trees or large branches can cause serious injuries, fatalities (social costs), extensive damage to property, damage to roads and disruption of mobility services.

RCT insurance policies do not always cover all the possible losses connected with climate-related events: in the case of damages to third parties due to falling trees, local governments are called to demonstrate the correct and accurate contract terms written for procuring urban maintenance services.

The involved UFMs are "public greenery monitoring and maintenance" and "roads monitoring and maintenance". These UFM services suppliers are requested to prove the correct and accurate performance of the assigned tasks specified in the contracts. In most cases, these two parties cannot provide the required information that could exonerate them from any charge.

In 2014, municipal officers and technicians noted that the main claims related to road accidents depended on imperfections in the road surface, damage to guardrails, or falling trees. Once established that high insurance costs (the high annual expenses in insurance deductible and insurance premium) were directly linked to road monitoring and maintenance, the local government intervened by re-writing the contract terms with Urban Facility Management services suppliers and re-designing the services delivery models and the connected information management processes, advised by and in close collaboration with the insurance broker.

The following requests to UFMs (public greenery monitoring and maintenance services and road monitoring and maintenance services) suppliers – in response to the problem of the high number of claims for compensation due to road accidents – were introduced into the new invitations to tender in 2015:

i) the design and implementation of an information system for the monitoring and management of road and public greenery maintenance services;
ii) the provision of an active surveillance service for road surface and tree monitoring;
iii) the provision of a first-aid trees and road surface maintenance service.

The UFMs suppliers were contracted in 2016 and agreed on the following points:

i) developing a web-gis cadastre of road network and guard rails within the municipal territory and an information system to make the information in the database (cadastre) accessible and updatable. The UFM services suppliers themselves were responsible for the management of the database and the information system;
ii) the possibility of updating data by directly entering maintenance or extra-ordinary works on infrastructures for all the maintenance services operators (active surveillance, first-aid response, preventive and corrective maintenance);
iii) the automated dispatch of intervention requests, which activates the first-aid or preventive-corrective maintenance service.

This automated information management process enabled the implementation of preventive maintenance practices, of which the effectiveness has been demonstrated by the drastic reduction in the annual number of accidents since its implementation (see **Table 1**).

The insurance policy A – two-year duration, from 31/12/2013 to 31/12/2015 – provided for an insurance deductible of 2'500 €, which means that for any claim that requires insurance compensation, the insured (the local government) has to pay this amount. Accordingly, the Municipality spent 222,500 € on insurance deductible in 2014.

Furthermore, at that time, the local government was spending 300,000 €/year on RCT – the third-party liability policy – insurance premium.

The insurance premium for RCT insurance policies is calculated based on the annual number of claims for compensation received by the insured (the local government) in the last five years and on the risk analysis conducted by the insurance company. Given the high number of annual claims in the case study in the period before 2015, the RCT insurance policy's cost and terms resulted to be unfavourable for the local Public Administration.

Thanks to the re-writing of contract terms (Contract 2 in **Table 1**) for UFM services, the annual number of road accidents decreased by almost 50% in 2015 (from 89 in 2014 to 46 in 2015). Accordingly, the total annual expenses on insurance deductible was reduced to 115,000 € (against the 222,500 € of the previous year).

Table 1. Number of claims for road accidents in 1 year and related annual expenses on insurance deductible in the analysed case. Correlations with RCT insurance policies and Urban Facility Management (UFM) services contract specifications. Source: [26].

		Insurance services				Urban Facility Management services		
Year	Annual n° of claims for road accidents	Insurance deductible	Annual expenses on insurance deductible	Insurance policy (RCT)	Annual insurance premium	Insurance services supplier	Contract specifications	UFM (road) services suppliers
2014	89	2'500€	222'500€	Ins. policy A	300'000€	Supplier A	Contract 1	Supplier 1
2015	46	2'500€	115'000€				Contract 2	Supplier 2
2016	32	2'500€	80'000€	Ins. policy B	250'000€	Supplier B		
2017	32	2'500€	80'000€				Contract 3	Supplier 3
2018	40	2'500€	100'000€					
2019	35	2'500€	87'500€	Ins. policy C	120'000€	Supplier C		
2020	32	2'500€	80'000€					
2021	32	2'500€	80'000€				Contract 4	Supplier 4

In 2016 a further reduction in road accidents (from 46 in 2015 to 32 in 2016) was confirmed, which implied a further decrease in annual expenses on insurance deductible (80,000 €).

This trend continued in the following years, up to 2019, when, by these continuous reductions in the annual number of claims related to road accidents, the new insurance premium (insurance policy C in **Table 1**) stood at 120'000 € (less than half of insurance policy A).

7. Discussion

This analysis leads to the conclusion that the implementation of effective soft-adaptation solutions relying on urban maintenance reorganization requires the following preconditions:

i) The availability of insurance brokers performing the following tasks: assessing the risks related to climate change (risk analysis), estimating the impacts of extreme events based on statistics and forecasting models, co-developing adaptation solutions to prevent losses (economic, social, environmental) in close collaboration with local governments;
ii) The availability of innovative climate Adaptation consulting services suppliers, performing the following tasks: identifying specific adaptation needs, accessing climate datasets, selecting and processing information in a way that makes it applicable and usable for strategic decision-making at the local level, re-designing (where needed) the Urban Facility Management services delivery models, supporting local governments in re-writing the contract terms regulating UFMs supply, evaluating

adaptation measures effectiveness;

iii) Flexibility and modularity of contracts with UFM suppliers that allow to re-calibrate urban maintenance services operations and practices on new, variable climate parameters;

iv) The availability of tools and procedures for information management related to managing UFM services to achieve an optimal integration with climate services.

In the case study presented above, the preconditions i) and ii) were verified thanks to the single figure of the insurance broker, which assumed a double role by adding to its traditional tasks that of Adaptation consulting services supplier.

Looking at the evolutions outlined in **Table 1** of, on the one hand, the annual expenses on RCT insurance policies and deductibles and, on the other hand, the contracts regulating UFM services delivery models, it results clear how these two elements are closely linked. Therefore, the improvement in contractual conditions with insurance services suppliers (the reduction in annual insurance costs in favour of the local government) represents an indicator of the effectiveness of the implemented reorganizational, soft, adaptation solution (the re-design of Urban Facility Management services delivery models).

Some limitations of the present study should be stressed: the correlation between the improvements in insurance conditions in favour of the Municipality, the reduction in road accidents and the optimization of urban maintenance through the redesign of Urban Facility Management services delivery models may be questioned. Other factors such as insurance broker's improved negotiation skills, market dynamics, promotions by new insurance services suppliers and many others could be pointed out as contributing factors to the reduction in insurance premium cost. Similarly, it is not scientifically proven that the reduction in the annual number of claims connected to road accidents is univocally linked to the optimization of urban maintenance.

Further developments should clarify the complex intercorrelations between these multiple factors.

Nevertheless, the interpretation of this case study was supported and validated by a continuous dialogue with key stakeholders: municipal officers and technicians, UFMs and emergency services suppliers, and insurance brokers.

The growing demand for specialized consulting services for adaptation (Adaptation consulting services) calls for further developments and triggers new relationships and forms of collaboration between public and private stakeholders.

8. Conclusions

The observation of the real case contributed to shaping the idea that gaps and criticalities affecting climate adaptation processes lie not much in the single performed actions or information exchange as, instead, in the relationships network involving Adaptation services stakeholders and in the system of contracts and agreements regulating these relationships.

Within the array of urban adaptation processes, stakeholders, insurance brokers can play an important role in supporting cities in climate change impact mitigation: insurances are economic tools that can potentially be used to address the issue of adaptation to changing climate parameters not only by compensating damages and losses (ex-post) but also – and here lies the innovation – by providing information and advisory to design and implement climate adaptation measures (ex-ante).

Furthermore, the potentially significant contribution to adaptation made by Urban Facility Management services deserves great attention: while contributing to city preparedness – whereas they perform preventive monitoring and maintenance tasks on the urban infrastructures – they may replace emergency services in some tasks that are presently officially assigned to them or un-officially remitted to them. So far, emergency services have made up for the shortcomings of available UFM services, incurring inefficiencies.

To exploit the opportunity of employing UFM services in tackling climate change impacts, contract terms must be re-written in the perspective of their new function, and high integration with climate services (localized, high-resolution, short to medium-term climate information) must be achieved.

The desirable ex-ante intervention of insurance brokers in the re-design of Urban Facility Management services in close collaboration with local governments constitutes by itself, according to the view proposed in this paper, a soft-approach, low-regret and co-benefits adaptation solution.

This vision springs from the reading of reality through the lens of specific adaptation needs and goes in the direction of digging up available resources – tools, information,

competences – in the current environment of heterogeneous stakeholders involved in adaptation processes, to find out that available resources often result potentially sufficient to increase the resilience degree of human systems, provided that some conditions are met.

Author Contributions

Every authors gave their contribution in the preliminary research phase and to the development of the pilot-case presented in the paper. C. Bernardini and G. Paganin have conducted the interviews to the representatives of the insurance industry and of the local governments involved in the development of the pilot-case. C. Bernardini produced the first draft of the paper and G. Paganin and C. M .L. Talamo have reviewed, corrected, integrated and edited the text.

Conflict of Interest

There is no conflict of interest.

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