ABSTRACT

Climate change is manifesting its influence on urban areas, intensifying apprehensions regarding their resilience in the face of future challenges. The challenges are notably pronounced in coastal city regions, marked by high population density and land use. Alongside the established perils inherent to coastal cities, such as irregular precipitation and cyclical water level fluctuations, the Caspian Sea region carries its own unique range of challenges associated with urban and industrial development, including activities like oil exploration and exploitation. The challenges associated with the Caspian Sea's rising sea levels for coastal areas highlight the importance of integrating natural and physical protective measures into the built environment. Within this context, various urban planning strategies play a crucial role in adapting to and efficiently managing a range of challenges, notably including flooding, displacement, and infrastructure damage.

Baku, the largest city in terms of both size and population along the Caspian Sea, also grapples with the hazards linked to increasing water levels in its coastal urban areas. This is a significant concern for the city, as the increasing complexity of disasters disproportionately affects its coastal areas. Furthermore, the cyclic environmental risks in coastal urban areas are compounded by the growing influence of climate change, seismic hazards, and the potential for associated tsunamis.

The article begins with the analysis of current resilient situation of Baku related to sea level rise, addresses risks related to ongoing urban projects on coastal areas and emphasizes the importance of transcending a one-sided (unidirectional) urban renewal approach. It illustrates the various components of a comprehensive and holistic (multidirectional) framework tailored for urban littoral areas, aimed at bolstering the resilience of Baku's coastal areas.

Keywords: Sea Level Rise Adaptation, Flooding, Coastal Urban Areas, Baku and Caspian Sea.

1. INTRODUCTION

The effects of climate change are affecting urban areas, giving rise to growing concerns regarding the resilience of cities. The increasing complexity of disasters also exerts a significant influence on coastal urban areas, where they face a heightened vulnerability to the consequences of flooding, waves, extreme sea levels, runoff, land subsidence, and other hazards [28]. Coastal urban areas, which are notably known for their high population density, concentration of economic activities and extensive land use [13], will experience the most pronounced effects of rising sea levels and extreme weather events in the next decades [37]. Approximately 38% of the global population resides in coastal areas, which are defined as regions within 100 kilometers of the coastline [49]. In the past three decades, coastal populations have witnessed a worldwide increase, surging from 1.6 billion to over 2.5 billion [49].

Meanwhile, the UN's proposed New Urban Agenda [50] addresses the significant threat posed by climate change and increasing sea levels to coastal urban areas, reflecting a global acknowledgment of the severity of this issue. The Agenda underscores the necessity of measures by emphasizing the impact of climate change, especially rising sea levels that particularly affect...
coastal areas, labeling them as vulnerable [50]. Alongside a significant population growth that surpassed 17 million by 2016, the Caspian Sea region exhibits distinctive vulnerabilities linked to urban and industrial development, encompassing activities like oil exploration [20]. These vulnerability factors coincide with the challenges faced by Caspian coastal cities, encompassing irregular precipitation and cyclical fluctuations in water levels, including both sea level rise and decrease.

The destructive impact of flooding and water level variability is also a notable concern for Baku, the largest city in the Caspian Sea region in terms of population size and the extent of urban and territorial transformation [3] [20] [1]. This is mainly because the increasing and compounding impact of multiple hazards and risks disproportionately affects its coastal regions, characterized by high population density and land use. Furthermore, the cyclical environmental risks in coastal urban areas are exacerbated by the growing impact of climate change, seismic hazards, and the potential for associated tsunamis [26] [30].

The mentioned challenges on the coastal urban areas can have adverse effects on the built environment as well as environmental and human security. An increase in water levels may lead to social and economic disruptions, environmental degradation, chemical pollution of waterfront areas associated with the oil industry, erosion, landslides, and more. Conversely, a decrease in water levels can result in issues like dust and sandstorms, storms, land salinization, and impacts on agriculture, ultimately affecting human security.

The various protective methods, encompassing both engineering and nature-based solutions, can actively contribute to reinforcing resilience, reducing and managing a spectrum of hazards and uncertainties in coastal areas. The efficient coastal management from flooding underscores the significance of establishing a comprehensive approach in urban development.

The article begins with the analysis of the current situation of Baku in terms of resilience related to a potential sea level rise, addresses challenges related to ongoing projects on coastal areas of Baku, and emphasizes the importance of transcending a one-sided (unidirectional) urban renewal program. The article finally illustrates the various components of a comprehensive and holistic conceptual framework tailored for urban littoral areas by referencing best practical cases from other cities. The aim is to strengthen the resilience of Baku's coastal urban areas.

2. METHODOLOGY

Methodologically, this article relies on a set of three complementary sources from Policy, Science, and Practical knowledge (fig. 1). Firstly, it involved consulting and collaborating with stakeholders from various public and private organizations enriching the article's knowledge with their insights (from 2018 to 2023). Following the presentations and illustrations of ongoing activities by organizations, the unstructured interactions (with no predetermined questions) with various organizations focused on the following elements:

- Understanding the specificity and nature of urban development and associated environmental hazards in coastal areas including in the context of the Caspian Sea;
- Understanding how various municipalities and local authorities consider the challenges posed by watershed and coastal flooding as well as sea level rise;
- Understanding the level of coordination of different organizations in developing strategies to address sea level rise and coastal flooding challenges.

Consulting and collaborating with stakeholders also facilitated obtaining reports and archival documents from the organizations mentioned in the references. Additionally, as part of showcasing best practices from other cities (see section 5), field visits and exchanges with stakeholders were also arranged in Switzerland (specifically, Geneva for the Aire River renaturation project) and in the USA (encompassing the West Coast, including Los Angeles and San Francisco, and the East Coast, with a focus on New York City).
Secondly, interactions with interdisciplinary scientific experts during the roundtables/conferences related to the Caspian Sea influenced the analysis of the article, incorporating complementary sources of expertise and knowledge. This additional expertise was gathered through interactions with scientific experts actively engaged in Caspian Sea research. This also occurred during expert meetings and working groups aimed to establish an interdisciplinary platform focused on addressing Sustainable Development Goals. Lastly, field visits to different coastal areas of the city of Baku with the representatives of organizations were indispensable for acquiring firsthand knowledge from on-site experiences (fig. 2).

These three crucial elements were integral in gathering the complementary data and sources, comprehending the local context, and understanding the unique nature of urban development in Baku's coastal areas.
3. FLUCTUATION OF THE CASPIAN SEA AND COASTAL URBAN AND INDUSTRIAL EXPANSION

The Caspian Sea, a major natural feature, is by far the largest landlocked saltwater body in the world with an area of over 371,000 km² [35]. The Caspian Sea plays a crucial role for riparian states such as Azerbaijan, Iran, Kazakhstan, the Russian Federation, and Turkmenistan, but it also presents challenges to the littoral areas of these states [20] [1].

In addition to the risks associated to coastal cities (irregularities of precipitation, cyclic changing of water level), the Caspian Sea has its particular risks related to the patterns of coastal urban development and industrial development. Ongoing activities in the Caspian Sea region include oil and gas exploration and exploitation, ship and diesel locomotive construction, as well as agricultural and fishing endeavors [20] [4] [5].

The Caspian Sea's water level, currently at -28 in altitude [32] has the potential to rise to a maximum of -25/-26 under specific conditions, such as continuously humid years. For instance, it was absolutely unexpected for the scientific community that the Caspian Sea level continued to decrease from the 1940s to the late 1970s, followed by a rapid 2.5 increase over two decades after 1977 [14] (fig. 3). The increase of sea level has caused flooding with the destruction or damage of buildings, engineering structures, roads, beaches, and farmlands in the coastal zone [42].

![Figure 3. Fluctuations in the water level of the Caspian Sea from 1840 to the present day, Source: Chen et al., 2013.](image)

The Caspian Sea level can fluctuate by up to 2.5 meters or decrease by 1.5 meters as part of its natural variation cycle [18]. These ongoing fluctuations are a result of changes in the water balance elements influenced by climate variations and the utilization of water resources in the sea's catchment area [34]. The water balance of the Caspian depends directly on climate change occurring throughout the Caspian Sea basin watershed to which the Volga river provides more than 80% of the water volume [2]. Furthermore, the cyclical environmental risks in coastal urban areas are exacerbated by the growing impact of climate change, seismic hazards, and the potential for associated tsunamis [26] [30].

Within this context, the 17 million inhabitants (data from 2016) living on the coastline of the Caspian Sea region find themselves facing the risk of flooding [20] (fig. 4). In terms of demographic growth and urban development patterns, Azerbaijan, Iran, and Russia exhibit higher populations in the Caspian coastal zones.
Figure 4. Population by number in the Caspian Sea region par cities and administrative units. Source: Indicated in the map, 2018.

In Iran, the three regions of Gilan, Mazandaran, and Golestan, which border the Caspian Sea, are also densely populated. In Russia, cities such as Astrakhan, Derbend, and Makhachkala, in addition to Turkmenistan's Turkmenbashi and Kazakhstan's Aktau, have developed around waterfronts [20].

In Azerbaijan, for instance, 66% of the population resides within 100 km of the Caspian Sea, and 36% of the country's population inhabits only 6% of its territory, mainly in Baku region [20]. Moreover, it has been disclosed that more than half of the coastal territory of the Republic of Azerbaijan experienced flooding during the rise of the Caspian Sea level by 2.5 meters in the period from 1978 to 1996 [2]. Within this context of flooding, the housing and economic structures situated along the entire expanse of the coastal zone under the threat of flooding have been identified including 50 settlements, 250 industrial enterprises and 60 km of highways [2]. The total area of the potential flooded areas in Azerbaijani coastal areas are 484.5 square kilometers [2].

4. NOTION OF RESILIENCE IN THE CONTEXT OF FLOODING

In general terms, the concept of resilience is frequently characterized as an "umbrella concept" [25] that serves to operationalize uncertainty in complex scenarios [15]. The term resilience is a relatively recent concept in the context of climate change and has a common
definition, which is: "[...] the ability to recover and adapt, to maintain sustainability within an organization or society, and to ensure a degree of continuity in a dynamic environment" [41].

Moench [31] and Proag [39] have delineated two overarching forms of the resilience concept. The first aspect is termed Hard resilience that pertains to the inherent strength of structures or institutions when subjected to pressure. In the context of disasters, resilience is often regarded as the direct opposite of fragility. For instance, engineers frequently focus on enhancing the resilience of a structure through specific reinforcement measures to decrease the likelihood of collapse when subjected to various stressors. As resilience increases, the extent of damage from a given level of hazard diminishes [31] [39]. The second facet is referred to as Soft resilience, meaning the capacity of systems to absorb and rebound from the effects of disruptive events without necessitating fundamental alterations in their function or structure.

These aspects can minimize damage related to flooding in coastal areas and losses by integrating buildings, infrastructure networks, and their functions. This may necessitate citywide adaptation efforts to mitigate adverse consequences. The potential benefits are twofold: reducing direct and indirect costs while minimizing operational disruptions and business interruptions. Additionally, urban planning, forms, network establishment, and infrastructure and service localization choices (with consideration for avoiding high-risk areas) may require innovation.

In simpler terms, within the realm of urban planning, a resilient city can be understood as a city with the ability to adapt to unexpected events, particularly in minimizing the impact of natural disasters. The ultimate goal is to swiftly restore normalcy in the face of such adversities. Essentially, a resilient city is one that possesses the capacity to navigate through unforeseen challenges, implementing effective measures to mitigate risks and ensuring a prompt return to a state of stability.

5. FROM INTERTWINED CHALLENGES TO INTEGRATED SOLUTIONS: COASTAL URBAN AREAS AS LIVING LABS

Climate change impacts are increasingly bringing the interconnected challenges faced by coastal cities to the forefront. Coastal urban areas, more than ever, are grappling with a multitude of challenges, serving as experimental grounds for new policies and strategies that address problems while emphasizing the urgency of integrated solutions. These solutions consider the green (biomass and vegetation), blue (water), and grey (built infrastructure) assets of urban areas. In this context, innovative policies like National Urban Policies are emerging to meet the governance demands posed by climate change [51] [23].

Recognizing that there is no one-size-fits-all approach to adaptation, the implementation of such strategies is heavily influenced by local conditions, impacting feasibility and outcomes [6]. Well-documented approaches to fostering enabling conditions for adaptation include integrated planning, collaboration among multiple agencies, and actions that span multiple scales and sectors [21].

In addition to conditions for adaptation, there are also potential solutions that could enable densely populated coastal urban areas to formulate resilience-based strategies, adapt to sea level rise and coastal flooding. The examples include several methods, drawing from practical examples and established best practices found in the context of other cities. On one hand, the responses aim to combat rising sea levels and coastal flooding or adapt to new climatic conditions, while on the other hand, they strive to establish the integrated management of these strategies [27]. Mainly, the possible responses for the city of Baku could potentially be classified into three main directions:

In contrast to "hard" engineering structures, coastal vegetated ecosystems and biogenic reefs possess the ability to self-adapt to rising sea levels through various mechanisms. Vegetated ecosystems can boost soil vertical accretion and elevation by accumulating substantial
belowground biomass and trapping particles from the water column [17] [22] [38]. In the context of the growing demand for cost-effective, sustainable, and resilient solutions, nature-based solutions are emerged as alternatives to address hazards while simultaneously promoting biodiversity [19]. Nature-based solutions encompass activities aimed at safeguarding, sustainably managing, and restoring natural or modified ecosystems that offer crucial ecosystem services for both human well-being and biodiversity [16].

The Canton of Geneva initiated its exploration of nature-based solutions by addressing the identified and mapped flood risks (fig. 5). Once these risks were identified, they were integrated into the urban planning and territorial development.

![Figure 5. Watercourse of the Canton of Geneva (left) / Stretches of watercourses - open sky, buried watercourse, pipeline, under body of water (right), Source: SITG.](image)

Even though the project in Geneva (Switzerland) is not situated on the seacoast, it serves as an example of nature-based solutions connecting the green, blue and grey assets. From identifying vulnerabilities and new sets of risks, the State of Geneva has aimed to enhance resilience and protect against flooding through watershed and infrastructure development. This project aims to position itself as an exemplary model for managing inherent risks in decision-making by thoroughly assessing, analyzing, and mitigating risks to increase the likelihood of successful decision outcomes.

- The Canton of Geneva's approach to addressing flooding risks through nature-based solutions.
This initiative aimed at spatial inversion, viewing green spaces as a connecting matrix between safeguarding natural heritage and urban modernity. Focused on renaturing the Aire area, the project prioritized nature as a social endeavor. The revitalization program responded to flood risks and environmental challenges, employing a multidisciplinary approach with architects, hydraulic engineers, civil engineers, and biologists forming an innovative collaboration. The project's approach allowed the river to choose its course, inducing controlled "chaos" through floods. Executed in multiple stages, the initiative utilized historical maps for a uniform structure. According to the Canton of Geneva [8], the project has demonstrated successful outcomes, restoring morphology and biodiversity, and witnessing the return of lost species.

**Figure 6.** Aire river revitalization project. Source: Canton of Geneva 2023, Fabio Chironi 2016.

b. Engineering-based solutions: the case of San Francisco

Throughout history, resilience was traditionally seen as a protection achieved by using engineering solutions as the main way to avoid risks [24]. This also required the maintenance costs of the structures, which could become unfeasible [33]. The main aim of engineering solutions was to involve intentional human intervention in altering the direction, attributes, or dynamics of water resources to manage them effectively, mitigate the threat of flooding, and facilitate smoother navigation across rivers.

- San Francisco's (USA) approach to addressing sea level rise through its Sea Level Rise Vulnerability Plan [44] serves as a noteworthy example of engineering solutions.
An integral measure within this initiative is the Embarcadero Seawall, a century-old foundation supporting over three miles of San Francisco's waterfront. Beyond current flood protection, the Seawall aims to provide a stable foundation for future sea level rise adaptation, along with reducing significant seismic risks.

**Figure 7.** Main elements of the Sea Level Rise Action Plan. Source: San Francisco Planning, 2016.

c. Innovation-based solutions: the case of New York City

Instead of constructing traditional infrastructure, adaptive responses for accommodation encompass a range of technological, architectural, and urban planning measures. Linham and Nicholls [29] encompass technologies and innovations that involve physical modifications to exposed buildings or infrastructure, such as elevating structures, providing individual protection, adjusting urban drainage systems, and experimenting with concepts like floating housing [48] and investigating the principles of "New Urbanism" [46].

- The New York (USA) Plan on Disaster Risk Reduction [36] focuses on enhancing the city's resilience against flooding.
An integral measure within this initiative is the Embarcadero Seawall, a century-old foundation supporting over three miles of San Francisco's waterfront. Beyond current flood protection, the Seawall aims to provide a stable foundation for future sea level rise adaptation, along with reducing significant seismic risks.

**Figure 7.** Main elements of the Sea Level Rise Action Plan. Source: San Francisco Planning, 2016.

The illustrated different solutions drawing from practical examples are the measures for enhancing resilience against flooding and sea level rise. These solutions encompass the concepts of Hard and Soft resilience. The first one is primarily aimed at bolstering an area's resilience through targeted reinforcement measures to reduce the risk of collapse under different stressors. On the other hand, the second one aims to enhance the ability of systems to absorb and recover from the impacts of disruptive events without requiring fundamental changes to their function or structure.

6. FLOODING CHALLENGES IN THE CONTEXT OF BAKU'S COASTAL RENEWAL STRATEGIES

In Baku, the largest city in terms of population on the Caspian Sea, 26% of the country's population — officially 2.5 million inhabitants — resides on just 3.2% of the territory in the Greater Baku region [8]. This region includes the cities of Baku, Sumgait, Xirdalan, and the urban installation of the new port of Alat in the south. In addition to dynamic demographics, the distribution of the population is also important because the concentration of a significant population in the Baku region undermines the resilience of coastal areas.
Furthermore, the Greater Baku region is the center of the oil industry, the main source of the national economy, and a site of intense migration. This region provides 98.3% (17,002 million manats in 2011) of the total state budget revenues [8]. Considering that Baku focuses primarily on the economic development of its coastal areas, the risk related to water assessment becomes increasingly significant. These fluctuations can have negative repercussions on the built environment and human security on the coastal areas, which positioned at the fourth and fifth levels of flooding risk (fig. 9). If we conduct the simulation as explained in figure 10, we can identify the areas that could potentially be inundated:

Certainly, the vulnerability and flooding simulation shown in this figure will not be linear. However, to better comprehend its significance, we have decided to utilize Google Earth to illustrate which areas will be conditionally flooded.
Baku Crystal Hall, an indoor arena inaugurated during the Eurovision Song Contest in 2012, is a critical city infrastructure that will be flooded in the event of a 2.5-meter sea level rise scenario.

The recently constructed Waterfront Caspian, an entertainment and leisure center, will also face flooding in the event of a 2.5-meter rise in sea level.

The primary promenade zone in the city of Baku, known as Baku’s Boulevard, encompassing both the historical old city and contemporary structures, is susceptible to flooding in a scenario involving a 2.5-meter rise in sea level. This buffer zone between the natural environment (the sea) and the built environment acts as a protective measure against environmental risks.

Figure 10. Selected critical infrastructures of the Baku’s Coastal Area. Source: Tural Aliyev, City Administration, Google Earth, 2023.

Within the mentioned challenges in coastal urban areas, it is crucial to analyze the specificity of ongoing coastal renewal projects to comprehend how the city addresses potential flooding scenarios. Three selected examples depicted in figure 11 offer a closer examination of the characteristics of urban renewal in coastal areas:

<table>
<thead>
<tr>
<th>Before 2010</th>
<th>After 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="before-2010-flag-square.png" alt="Flag Square before 2010" /></td>
<td><img src="after-2010-flag-square.png" alt="Flag Square after 2010" /></td>
</tr>
</tbody>
</table>

The Flag Square covers an area of 100 hectares (1 km²), and when combined with Water Place Square, the total
area is approximately 151 hectares (1.51 km²). The real estate market, both before and after renewal, reflects significant changes. In 2009, prices were at 1250 AZN per square meter. However, with the introduction of project such as Sabah Residences in 2019, prices have risen to the range of 1900-2800 AZN per square meter (equivalent to 1120-1650 US dollars) [43]. Field visits (see section 2) clearly revealed that the highway, acting as a connection between the city of Baku and the southern regions, still poses a significant barrier to connecting residents to Flag Square. As a result, there is limited access to the renewed area that affects its usage.

The transformed zone, transitioning from an industrial area to public space, covers an estimated 1 km². The ongoing renewal process in the Industrial Waterfront Area is primarily centered on beautification with a little incorporation of social and environmental aspects into the economic evaluation of the space. The renewed site, initiated since 2015 invests in an area that attracts relatively few people. Therefore, during the unstructured interactions with stakeholders (see section 2); the authorities demonstrated a willingness to learn from best practices on how to bring people to the newly created and renewed urban areas.

The former harbor zone has undergone a conversion into a real estate area with a business model primarily centered on beautification. The real estate prices, both before the initiation of the TAC Residences and Port Baku Residences and after, demonstrate a significant shift: in 2009, it was 1200 AZN per square meter, while in 2019; it reached 6000 AZN per square meter (equivalent to 3400 US dollars) [47]. Given its central location, this place has the potential to attract more people compared to the first two examples.

Figure 11. Selected coastal renewal projects. Source: Tural Aliyev, City Administration, Baku White City, 2023.

As illustrated in figure 11, the city of Baku is currently undergoing a renewal strategy with mainly a unidirectional, business-oriented approach [1]. The projects for the coastal areas focus solely on enhancing aesthetics and attractiveness following the Dubaification model [53] [1]. A holistic approach to urban development, moving beyond a mere emphasis on aesthetics and attractiveness, could potentially address the flooding challenges in Baku's coastal urban areas and integrate social and environmental aspects into urban development (see section 7).

7. INTEGRATED URBAN RISK BASED PLANNING: BEYOND UNIDIRECTIONAL ECONOMIC FOCUS ONLY

The process of planning for resiliency delineates a systematic approach to strengthen the resilience of coastal urban areas against the challenges posed by rising sea levels (fig. 12). The process initiates with a comprehensive examination of scientific assessments, aimed at
understanding vulnerability and risk. Subsequently, an adaptation plan is formulated, and measures are implemented and monitored to ensure their effectiveness.

The planning process for resilience, as elaborate for California, provides a basis for the conceptual framework for Baku's coastal urban areas as depicted in figure 14. Several process steps are borrowed, including Review Science (as outlined in the theoretical section concerning resilience, vulnerabilities, and natural variation cycle fluctuations), or Assess vulnerability and risks (as demonstrated in flooding scenarios and challenges related to coastal urban and industrial expansion within the context of Baku's coastal renewal strategies). The integrated urban framework proposed in this article (fig. 14) also follows and aligns with the fourth step of the process of planning for resiliency (Development Adaptation Plan).

![Figure 12. The process of planning for resiliency of coastal urban areas, San Francisco Planning, 2016.](image)

In addition to mapping environmental risks and vulnerabilities in urban areas, adapting to flooding in the coastal urban areas of Baku could also benefit from an integrated approach to risk processing in urban areas, drawing inspiration from the Swiss example. The conceptual framework presented below is characterized as a comprehensive and holistic approach that extends beyond a one-sided economic profit focus (unidirectional approach) (fig. 13).

The illustration below exemplifies (fig. 13) the principle that when determining the optimal action plan, all conceivable measures for preparedness, response, and recovery should be taken into consideration. Given the fluid boundaries between these three domains concerning the actual measures, seven more detailed subdomains are outlined: prevention, emergency provisions, preparations for intervention, intervention, reconditioning, event analysis, and reconstruction.
Inspired by the Integrated Reflective Cycle [9], figure 14 incorporates elements from models outlined in figures 12 and 13. It guides through four steps, involving the consideration of experience, actions, relevant theory, and preparation for the future. By reflecting on these four steps, the article derives an Integrated Urban Risk based Planning (fig. 14) based on the mentioned components.

The experience represents the Method (nature-, engineering-, and/or innovation-based approaches have already been demonstrated, as evidenced by the case studies of the cities of Geneva, New York, and San Francisco) that could potentially be implemented; the actions correspond to the Objective (resilience building); theory aligns with the Aim (comprehensive and holistic approach), and preparation for the future relates to the Strategic Axe.
The figure 14, labeled as Integrated Urban Risk based Planning, illustrates the integration of risk processing into the planning process. In essence, territorial planning is developed in consideration of the identified risks.

The Integrated Urban Risk based Planning, which is a conceptual framework, aims at integrating social and environmental considerations into the economic aspects of projects. It involves the following steps:

- Firstly, the framework asks about the aims of policymakers and urban planners. It could include elements such as preserving natural capital, cultural heritage, and mitigating densification and gentrification in the coastal area, corresponding to a comprehensive and holistic approach which is characterized as a contrary to the unidirectional focus.
- Secondly, the framework asks about the method on how to react and intervene. It could integrate combined methods such as nature-, engineering-, and/or innovation-based approaches as presented in this article.
- Thirdly, the framework asks about the objective on how to achieve the aim. The objective is to enhance the resilience of coastal areas against flowing. To achieve this, the framework suggest incorporating elasticity to variability, absorption, adaptation to climate change, promotion of walkability and biodiversity, and the integration of urban forms and transportation with blue and green belts.
- Finally, by following these three steps, strategic axes could be established, addressing the question of what to achieve in the long term. It could include the elements such as creation of new values (economic, social and environmental ones), restoration of social bonds, and promotion the health and well-being of its citizens over the long term.

The Integrated Urban Risk based Planning is intended to support Baku City General Plan 2040 [7] that should help bolstering the resilience of coastal areas. It aligns with the Sustainable Development Goals (SDGs), particularly within the context of Disaster Risk Reduction as a component of Urban Development for Coastal Areas. The Integrated Urban Risk based Planning corresponds to Target B1 of SDG 11, which measures the proportion of local governments adopting and implementing local disaster risk reduction strategies in accordance with the Sendai Framework for Disaster Risk Reduction 2015-2030 [52]. Particularly, it addresses the priority on enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery,
rehabilitation and reconstruction of Sendai Framework [52]. This method is also in line with other SDGs such as, e.g., SDGs 3 on healthy lives and promotion of well-being, SDG 8 on promotion of sustained, inclusive, and sustainable economic growth, SDG 13 on taking urgent action to combat climate change, and SDG 9 on building resilient infrastructure.

8. DISCUSSION AND CONCLUSION

This article discusses Baku's current coastal resilience challenges related to the fluctuation of the sea level and demonstrates potential flooding scenarios in coastal urban areas. It delves into the risks associated with Baku's ongoing coastal renewal projects based mainly on an economic focus with little consideration of sustainability and resilience elements.

Based on the employed methodology, the article emphasizes that the primary reasons for the limited attention to a sustainable and resilient approach in coastal urban areas include the division of littoral areas among various public entities, the absence of disaster risk reduction strategies for coastal areas at different levels — ranging from city to regional to national levels — and a shortage of localized knowledge and best practices from other cities in building resilience in coastal areas. The proposed framework aims to address the absence of two crucial elements by recommending a comprehensive and holistic approach (multidirectional) to disaster risk reduction, particularly concerning strategies for coastal flooding at the city level. It also seeks to underscore the significance of localizing best practices from other cities within the context of Baku to enhance resilience in coastal areas.

The article underscores the significance for incorporating considerations of sustainability and resilience in waterfronts and underscores the significance of transcending a unidirectional urban renewal approach based on economic (short-term) benefits only. The article outlines the components of Integrated Urban Risk based Planning, a comprehensive and holistic conceptual framework tailored for coastal urban areas. The primary objective is to enhance the resilience of Baku's coastal regions. The Integrated Urban Risk based Planning aims at integrating social and environmental considerations into the economic aspects of projects and outlines steps for enhancing coastal resilience to natural hazards within coastal urban areas. It proposes here holds the potential for practical implementation and requires testing and refinement, emphasizing that it is a work in progress. Such testing and refinement processes correspond to the fifth step of figure 12, as part of the implementation of adaptation plan.

In addition to the political willingness for the implementation of the Integrated Urban Risk based Planning, further conditions are needed for its sustainable realization. New sets of data, tools, forecasting, and scientific advancements could help to assess risks, challenges and vulnerabilities. Moreover, community engagement is vital for co-monitoring the implementation of the adaptation plan (sixth step of figure 12). This approach is designed to meet the needs of the population, fostering a sense of ownership and collective responsibility in shaping the future of coastal regions. Furthermore, fostering interdisciplinary approaches and encouraging the emergence of expertise from various sectors is essential for the implementation of the framework. In tandem with this interdisciplinary approach, it could be important to build new sets of expertise, breaking down silos and integrating knowledge from diverse fields. In addition to figure 12 and 13, the proposed Integrated Urban Risk based Planning (figure 14) aims to elucidate the strategic steps and their intended purposes that should be taken, along with identifying additional targets it could respond to, all while maintaining a focus on the overarching goal.

In conclusion, localization is more important than ever to adapt to local context, and territorial planning is crucial in handling the distribution of the population at the national level to reduce risks associated with high-density coastal areas of Baku and concertation of strategic infrastructure. Besides, a resilient and sustainable city has the potential to positively influence real estate prices and foster tourism development. This aligns seamlessly with the ongoing
efforts of Baku’s authorities in their coastal renewal projects, reflecting a strategic focus on sustainable urban development for long-term economic prosperity.

In future research endeavors, it is crucial also explore the implications of decreasing water levels on coastal urban areas. While the current literature predominantly focuses on addressing challenges related to sea level rise and developing adaptation strategies, investigating the potential impact of sea level decrease on coastal urban planning and formulating appropriate strategies becomes particularly significant. This importance is underscored in the case of the Caspian Sea, where evidence indicates a potential decline in its water level. Such a decline that could be unexpectedly followed by a rapid 2.25-meter increase over two decades, as it happened after 1977, raises significant concerns for coastal areas. Coastal urban strategies for adaptation, especially in the case of Baku and the Caspian Sea, need to consider both rising and falling sea levels for comprehensive planning.

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