Embedding resilience of urban areas to climate change: a case study of Rotterdam

Anna Bilska
Poznan Municipal Town Planning Office
anna.bilska.ab@gmail.com

Abstract
Climate change may have severe consequences for urban areas and many cities, such as those situated on deltas, are already threatened. The paper claims that the solution for endangered areas is the embedding of urban climate resilience. The concept of resilience is put forward to bring a broad perspective to a city with an indication that the city is a complex system with developed relations, both inward and outward. Social and institutional aspects of these relations are highlighted as they have the highest potential to make the city resilient. The paper indicates three fundamental features of embedding the resilience of urban areas to climate change: network building, a strategic approach and implementing urban projects. A practical application of these fundamental features is evaluated using the case study of Rotterdam. The research shows the reliability of these bases and indicates key characteristics of each fundamental feature: the network should be multidimensional with solid institutional and interpersonal relations, the strategy should have a holistic approach and project implementation needs the engagement of all the city actors.

submitted: October 2017
reviewed: December 2017
accepted: March 2018

© 2017 Anna Bilska. This is an open access article licensed under the Creative Commons Attribution-NonCommercial-NoDerivs License (http://creativecommons.org/licenses/by-nc-nd/3.0/).
Introduction
The objective of this paper is to present the fundamental features of embedding resilience to climate change in urban areas with an emphasis on systems thinking and institutional relations. It is argued that under conditions of climate change, safety in urban areas can be achieved when a broad perspective on a city is taken into account. This means that the city is perceived as a complex system, which has developed its inner network and interacts with other systems. These inner and outer relations of the city are shaped and constantly modified by social and institutional factors. If the city is considered as a system, it may become resilient when the relations of its network are strong and, at the same time, adaptable (Pisano 2012). This ensures the flow of information, knowledge, and innovation and may lead to a state in which the city is prepared for the consequences of climate change. Therefore, the concept of resilience has first to be embedded in society and in institutions that are able to shape the urban network. The paper focuses on institutions, as they have the power to create regulations, cooperate with other organizations and give guidelines. Moreover, the institutional dimension plays a key role in promoting the transition from planning to the implementation of resilience (IPCC 2014). Nonetheless, the importance of society is also indicated.

The approach of the paper is rooted in two concepts, embeddedness and resilience. The concept of embeddedness (Granovetter 1985) highlights the importance of social and political contexts. The concept of resilience (Holling 1973) draws attention to the fact that the whole system should have the capacity to adapt to new conditions. These theoretical ideas are expanded in the first part of the paper. They are less commonly discussed with reference to climate change than are adaptation and mitigation (OECD 2010; CDC 2013). The idea of resilience is used in the paper to indicate that it implicates a broader approach than adaptation. Consequently, it may prepare every component and every relation in the complex urban network to face threats. The paper deals with urban climate resilience as a solution for cities to respond to changing conditions. From a review of the literature, three main fundamental features of embedding resilience in urban areas to climate change are indicated in the paper, each of them is discussed using the case study of Rotterdam. The key questions addressed by the paper are how the theoretical basis of embedding resilience of urban areas to climate change works in practice and what characteristics of each fundamental feature are indicated by the case study. Moreover, the paper emphasizes the institutional aspects of urban climate resilience.

The case study city, Rotterdam, is a model example of a climate resilient city (Stead 2014). Despite its delta location with more than half of the city area below sea level, Rotterdam is well prepared for the severe conditions that can occur as a result of climate change. It is worth mentioning that delta cities are some of those most exposed to the consequences of climate change and they already have to deal with a higher frequency of extreme weather periods. Moreover, Rotterdam has managed to cope with several destructive floods. That has contributed strongly to the conscious and effective embedding of resilience in Rotterdam. What is more, it is rooted in the community and institutions which have to live with unfavourable weather and geographical conditions. Consequently, society and institutions have been acting and collaborating for a long time to create satisfactory conditions for city development. The importance of social relations is clearly visible in Rotterdam.

Methods
The data for the research was collected by:
- field survey;
- semi-structured interviews;
- analysis of Rotterdam official documents.

The field survey was conducted by the author at the end of 2014 with the aim of identifying and classifying resilient urban projects implemented in Rotterdam. During the research 63 urban projects were identified that had been implemented and which were related to climate change. Some of them were extensions or enhancements of earlier developments e.g. heightening and adapting dikes.

The research was conducted in four stages:
1. identification of urban developments related to building resilience;
2. creation of a survey sheet;
3. land inventory of the urban developments identified: filling-in the survey sheet, mapping and photographic documentation;
4. analysis of results.

The following information was included in the survey sheet: (1) name of the project, (2) urban development type, (3) mitigated threats of climate change, (4) functions of the development, (5) initiator, (6) whether cooperation was included during implementation, (7) area of impact. The information filled-in on the sheet was generalised for better comparability. For example classifications were created for types of urban development (public space, building development, infrastructure, other), initiators (Rotterdam Municipality, Port of Rotterdam Authority, local society, private entity), and areas of impact (building, housing estate, district, city). Survey sheets were processed in Excel using statistical techniques.

The interviews, conducted in November and December 2014, involved an official in City Hall, two academics at the Institute for Housing and Urban Development Studies at Erasmus University in Rotterdam, a flood defence specialist...
The study of the strategies and plans for Rotterdam related to climate change, resilience and adaptation gave an overview on the complex and infinite process of embedding climate resilience. The study of local documents was preceded by a review of four national documents which were the precursors of the discourse on climate resilience:

1. Programme on Climate Adaptation and Spatial Planning (2007);
2. National Vision for Water Management (2007);
3. National Adaptation Strategy (2007);

The following seven local documents were studied:

1. Rotterdam Urban Vision. Spatial Development Strategy 2030 (2007);
2. Rotterdam Water Plan (2007);
3. Rotterdam Adaptation Programme 2009;
4. Rotterdam Climate City Mitigation Action Programme 2010;
5. Structural Vision for the Stadshavens area (2011);
6. Rotterdam Adaptation Strategy (2013);

Fundamentals of embedding urban climate resilience

The concept of a resilient city is relatively new in urban studies. The idea of resilience arises from ecology (Holling 1973), economy (Pike et al. 2010; Vale 2014) or epidemiology (Dieleman 2013). Urban resilience is multidimensional because it is related to social, economic and environmental aspects. However, some scientists emphasise only economic resilience in regional and city studies and perceive it as an ability to bounce back after disaster and as a resistance to disturbances (Pike et al. 2010). The understanding of resilience in this paper is closer to C. S. Holling’s definition of resilience in ecological systems: ‘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’ (1973: 17). As the city is a complex system and the relationships within it are crucial for its development, Holling’s approach seems to be correct. Focusing on a climate resilient city requires a bit more specific definition as the most important for the city is the ability to persist despite the negative effects of climate change. Therefore, city resilience is understood in this paper as a capability to consciously react to current or potential dangers and mitigate their risk.

The increasing pressure, uncertainty and a number of threats to urban areas lead to growing popularity of the resilient city concept. Although cities have been struggling with different environmental, economic, social or infrastructural problems since their foundation, trouble is even more perceptible nowadays. According to the United Nations report ‘World urbanization prospects’ (UN 2014: 1) 54% of the population in 2013 lived in urban areas and it is predicted that the number will grow to 66% in 2050. The problem is that the consequences of climate change are more severe in highly populated areas. An intense concentration of human, social, financial and manufactured resources in cities causes disasters to result in a relatively higher impact than in less populated areas, for example, the costs of all natural disasters in urban areas in 2011 were estimated to be around 380 billion dollars (UN-Habitat n.d.). Also, hurricane Katrina in 2005 caused the population of New Orleans to decrease by one-third (Desouza & Flanery 2013: 89). One of the most recent examples is the devastation caused by Hurricane Harvey in Houston in August 2017.

Resilience may become a solution to the unpredictable and vicious consequences of climate change. It is more than adaptation to climate change. A resilient city has a capacity to respond to changes in multiple ways that allow it to recover, mitigate, bounce back, rebuild, grow and adapt. It is possible only by indicating specific dangers such as flooding, shifting rainfall, droughts and by gaining knowledge of the weaknesses and problems in the particular urban system. Furthermore, it is very important to take into account the social aspects of relations in a given system, which makes it possible to assess the influence of threats on the whole urban system, on specific components and on specific relations. Assessment of the strength and speed of a feedback loop allows us to estimate how fast changes in one part of the system can impact other areas or how fast information is transferred. That is a straightforward way to identify key areas which need enhancement. It means that the understanding of relationships within a city network is crucial. It is especially connected with institutional and social relations, as they are a source of information and innovation. It should be stated that an urban system is a component of a bigger system like a region, a country or even the world. Therefore, relations spread beyond city borders.

Information and experience from outside may also increase urban resilience (Pisano 2012; Dieleman 2013). It is argued that network building among city actors and network building with other cities and units is the first fundamental feature of embedding urban climate resilience.

The network is created by city actors and outside units, so social, cultural and political aspects may influence this network and as a result also its resilience. The importance of these aspects is presented by the concept of
embeddedness. The concept was created by economic historian K. Polanyi and it was further developed by economic sociologist M. Granovetter, who argued that economic activity cannot be perceived without social, cultural and political contexts (Granovetter 1985). The concept is currently applied to emergency situations as relational and institutional embeddedness occurs to improve the interactions of society, institutions and other actors and consequently it has an influence on the effectiveness of a response to a disaster. Studies indicate that, for example, disaster agencies collaborate more effectively with others when a communication network is well developed, when they know each other and when the interactions are rather informal (Nowell & Steelman 2014). The embeddedness framework may also be useful in creating a resilient city. K. Thompson-Dyck et al. (2016: 281) indicates four dimensions for resilience: cognitive, cultural, structural and political embeddedness. The cognitive one refers to individuals and their limited abilities to make fully rational decisions. The cultural one applies to values and norms in particular areas. Structural embeddedness refers to relations, networks and ties between all the city actors. Political embeddedness shapes the institutional context. Structural and political embeddedness seems to be fundamental to urban climate resilience.

The importance of a network was mentioned earlier. The political aspects are significant since the city authorities are decision makers and are in possession of the greatest power to make the city safe (UNISDR 2013). There is a need for a proper approach to policy because many threats to the city are only forecasts and it is crucial to be aware of unpredictability. It is particularly important in the case of climate change because effects like extreme weather are often unpredictable. Consequently, focusing only on climate change can be misleading and appropriate institutions are needed. It is argued that the second foundation of embedding urban resilience is a strategic approach. A proper strategy should indicate aims, priorities and specific plans.

Both network building and strategic planning may serve as a solid framework for the implementation of resilience. Most urban strategies contain general frameworks, rules or long term visions that need to be translated into actions which produce advantages for the whole urban system. The effects of climate change may impact urban structures, infrastructure, buildings, and this is a main threat to people. Therefore, factual resilience can be built through urban developments (Eraydin & Tasan-Kok 2013; Stead 2014). Urban projects should comply with the priorities and aims of strategies related to climate change. Then implementation of these projects leads to the emergence of a resilient city. Consequently, the third foundation of embedding urban climate resilience is the implementation of urban projects (Fig. 1).

**Network building**

The idea of resilience is strongly connected with systems thinking. Therefore, a city cannot become resilient without taking into account different, internal networks, as well as a city’s inner relations. Urban resilience often depends on the resilience of its environment. Particularly, if a greater region than a city area is endangered, then a higher level of governance should be
involved. Local authorities cannot cope with the risk on their own, so the institutional context is an important factor. The Municipality of Rotterdam needs to cooperate with higher levels of administration, especially on water issues, which is caused mainly by an increasing need to integrate water management with spatial planning. Rotterdam is under the governance of three regional water authorities: Delfland, Schieland & Krimpenerwaard and Hollandse Delta. Until the end of the 1990s, cooperation between the city planners and water authorities had been negligible and spatial development had had a negative impact on the capacity of water systems to handle large fluctuations in water (Eraydin & Tasan-Kok 2013: 214). It occurred that multifunctional solutions and firm cooperation were needed to cope with an increasing amount of water in high density urban areas. A Governmental Commission on Water Management in the Twenty-First Century was established. Consequently, the responsibility for water management in cities was divided between the municipality and water authorities and that enforced closer cooperation between them. A milestone within the cooperation in Rotterdam was informal collaboration. During the International Architecture Biennale Rotterdam in 2005 the Rotterdam Water City 2035 project was created. It was developed by members of the Urban Planning Department, Economic Development Department, regional water authorities and some experts. An absence of political negotiations during the biennale gave rise to creativity and innovation in the project. The popularity of Rotterdam Water City 2035 resulted in the creation of a formal document, the Water Plan, which was adopted in 2007. What is more, the document is integrated in the Rotterdam Spatial Development Strategy 2030 (de Graaf & van der Brugge 2010). It shows the importance of institutional, and at the same time relational, embeddedness to produce success in building a resilient city.

In the case of huge threats, like climate change, the collaboration of different departments and different levels of governance within a country may be insufficient. Furthermore, international cooperation may have great advantages. Apart from implementing European and international regulations concerning climate change, Rotterdam is active in five international organisations and initiatives relating to climate change and urban resilience: Connecting Delta Cities, the ‘Making cities resilient’ campaign of The United Nations Office for Disaster Risk Reduction, the ‘Transitioning towards urban resilience and sustainability’ initiative, 100 Resilient Cities and the Carbon Disclosure Project. The main aim of these organisations and initiatives is to build and enhance a global network of cities with similar problems, with such a network enabling diffusion of knowledge, creativity and innovation. Some organisations fulfil advisory functions, some give financial support and expertise. Currently, the know-how and climate resilience in Rotterdam are both so developed that the city is one of the main advisors and headquarters for Connecting Delta Cities. Rotterdam is sharing its experience and knowledge with others. For example, a ‘Brooklyn-Rotterdam Waterfront Exchange’ event was organized in 2010 to discuss how to combine economic development with environmental sustainability and climate resilience in port cities (Aerts & Botzen 2011).

National and international relations are very important. Nonetheless, relations between city actors may become crucial for the implementation of practical solutions to embed resilience. One of the most important cooperation types in Rotterdam is cooperation between the municipality and port authority. The port of Rotterdam is the biggest and most profitable business entity in the city. However, at the same time, the port is a major contributor to carbon dioxide emissions. Being conscious of the climate change threats, the port authority takes intensive action to reduce the negative impact on the environment. The collaboration of the Port of Rotterdam Authority with the City of Rotterdam, Deltalinqs and DCMR Environmental Protection Agency Rijnmond resulted in the establishment of the Rotterdam Climate Initiative, which is currently the main institution which is working to promote resilience (Fig. 2). Because of its significant impact on climate, actions undertaken by the port are crucial and the port is doing its best. According to the Port Authorities report, between 2010 and 2013 the emissions of CO₂ were reduced by 6.1% (Port of Rotterdam n.d.). More importantly, the Port Authorities became a role model for embedding resilience in the immediate neighbourhood and one that could attract others to do the same.

A strategic approach

Due to the complexity of urban systems, the embedding of resilience is not possible without strategic planning and new regulations established by the adaptation of documents, strategies, and programmes. The cooperation and local regulations should be based on documents from higher levels of governance. The Rotterdam strategy is considering issues of climate change and resilience by taking into account official national papers such as the: ‘Programme on Climate Adaptation and Spatial Planning’, ‘National Vision for Water Management’, ‘National Adaptation Strategy’, and ‘National Water Plan’. These documents give general guidelines with the intention of building a resilient country. The first document emphasises the role of spatial planning in gaining durability, resilience and adaptive capacity under conditions of increasing risk of the consequences of climate change. All
According to P. Lu & D. Stead (2013) the high vulnerability of the Netherlands to the consequences of climate change was the reason for that early action.

At the local level the main document of the Rotterdam spatial planning strategy is the ‘Rotterdam Urban Vision – Spatial Development Strategy 2030’. The document omits climate change and water issues and highlights the importance of a strong economy and the residential attractiveness of the city. However, these strategy goals cannot be achieved without the second important document, the ‘Water Plan’, which is complementary to the spatial development strategy and takes into account all water issues in the city. Both documents were adopted in 2007 and have served as frameworks to build a resilient Rotterdam.

More detailed plans and actions to adapt to or mitigate the consequences of climate change are established by the Rotterdam Climate Initiative. The documents of the initiative aim to fulfil two major climate goals of Rotterdam: a 50% reduction of CO₂ emissions and to 100% climate proof to 2025. The Rotterdam Climate Initiative has adopted a few minor action programmes to mitigate and adapt to climate change at the beginning of the activity. After that ‘the Rotterdam Adaptation Strategy’ was created in 2013. It is a complex, official paper that regulates all issues of possible risks due to change in the climate. The strategy gives an insight into the solutions for different scales: city, districts and buildings. The innovative approach of the strategy is that the city is taking into account not only challenges but also opportunities. For example, an increasing amount of water can be used to create attractive public spaces.

Currently, the ‘Rotterdam Adaptation Strategy’ is a supplementary document to the ‘Rotterdam Resilience Strategy’, which was adopted in 2016. This strategy was developed with the help of the 100 Resilient Cities organisation. Rotterdam used the methodology and tools developed by 100 Resilient Cities to build the strategy. One of the main statements in the document points out that resilience is not only adaptation to climate, but also that ‘cities that have

---

**Figure 2**

Network of actors involved in creating urban resilience in Rotterdam

Source: own diagram
considered their resilience in a holistic way will be better prepared for the future’ (Rotterdam Resilience Strategy 2016: 15). Rotterdam takes into account all the issues in the city and understands that focusing only on one aspect and neglecting others cannot bring sustained resilience. The main goals of the strategy are: a balanced society, a world port city built on clean and reliable energy, the Rotterdam cyber port city, a new level of adaptation to climate change, an infrastructure ready for the 21st century, Rotterdam the network city, and anchoring resilience in the city. All these goals can be adapted in other cities, as they consider: society, main business entities, new technology, climate change, infrastructure, the network and resilience itself.

**Project implementation**

Network and strategic planning are just a way to build resilience. Most of the documents discussed in this paper contain general frameworks, rules or long term visions that need to be transformed into actions, which will possibly result in advantages for the whole urban system. As climate change is a meaningful and widely discussed issue in Rotterdam, a lot of initiatives, actions and developments have already been implemented to become better prepared for the future. During the research conducted in Rotterdam at the end of 2014, a survey was made of 63 urban projects related to climate change which had already been implemented. Table 1 presents the generalised results of the research.

One of the most interesting conclusions of the research relates to the initiator. Although half of the developments identified were implemented by the Rotterdam Municipality as a result of written plans, a significant number of projects were rooted in bottom-up actions. The fact that citizens and stakeholders are unusually engaged in the development of the city is probably one of the major factors of success in embedding resilience in Rotterdam. Resilience comes from mutual actions and the engagement of as many partners as possible: citizens, stakeholders, city departments and authorities. This fact is also indicated by the research results – about a half of the developments resulted from cooperation between the municipality and other city actors. What is more, all developments which were able to influence significant areas, such as the whole city or a big district were implemented as a result of cooperation. That indicates the importance of structural embeddedness to resilient developments.

Another factor in Rotterdam’s success as a resilient city is undoubtedly the versatility of urban developments. They were created not only to adapt to climate change or mitigate its effects but also to create a new public space, services, make the place more attractive, etc. Consequently, the implementation of expensive solutions was reasonable and profitable. In particular, if the development is about to mitigate a predicted effect of climate change, which may possibly occur in the future, it is obvious that versatility is necessary. Therefore, sometimes adaptation to climate change is only a minor function of the development. This is also a result of strategic and comprehensive thinking. One of the threats with minor probability in Rotterdam is a flood storm. However, it is also one of the most dangerous natural events and its economic and social consequences would be enormous. Rotterdam was almost totally

| TABLE 1 |
| General results of the survey of urban projects related to climate change |
| Source: Field survey conducted by the author in Rotterdam in 2014 |

<table>
<thead>
<tr>
<th>Urban development</th>
<th>Number of projects</th>
<th>Percentage of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public space</td>
<td>26</td>
<td>42%</td>
</tr>
<tr>
<td>Building development</td>
<td>19</td>
<td>30%</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>12</td>
<td>19%</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>9%</td>
</tr>
<tr>
<td><strong>Initiator</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotterdam Municipality</td>
<td>31</td>
<td>50%</td>
</tr>
<tr>
<td>Port of Rotterdam Authority</td>
<td>5</td>
<td>8%</td>
</tr>
<tr>
<td>Local society</td>
<td>14</td>
<td>22%</td>
</tr>
<tr>
<td>Private entity</td>
<td>13</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Area of impact</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>15</td>
<td>24%</td>
</tr>
<tr>
<td>Housing estate</td>
<td>16</td>
<td>25%</td>
</tr>
<tr>
<td>District</td>
<td>24</td>
<td>38%</td>
</tr>
<tr>
<td>City</td>
<td>8</td>
<td>13%</td>
</tr>
<tr>
<td>Multifunction</td>
<td>43</td>
<td>62%</td>
</tr>
<tr>
<td>Cooperation during implementation</td>
<td>26</td>
<td>41%</td>
</tr>
</tbody>
</table>
destroyed by a storm in 1953. This event initiated intensive activity to protect the city from floods. Nowadays, Rotterdam’s flood defence system is one of the most secure in the world (Dircke et al. 2012). Although a flood storm probability is estimated as one in a few thousand years, the city is still increasing reinforcement, for example dikes are being rebuilt and strengthened. Also, other functions are applied to dikes to make these developments economically reasonable. Furthermore, reinforcing of one of the major dikes in the city resulted in the location of stores and car-parks in the dike and the creation of a roof park on top of it. Consequently, a huge area occupied by the dike has been turned into a work-place and a big public park (IABR 2014).

Another advantage of urban resilience is the ability to turn a problem into an opportunity. The research indicates that 11% of urban projects not only protect the city from climate change but also take advantage from possible risks. Some of the urban projects that have been implemented use increasing rain water to make public space more attractive and some of them could bring financial benefits to the city and increase innovation despite increasing threats. The model projects which turn a problem into an opportunity are water-squares, which can be called a new generation of creative and innovative urban spaces. Water-squares are public spaces that meet the recreational needs of the community and at the same time function as a water storage facility. The first water-square in the world was built in Rotterdam at Bethemplein. Currently it is a model example of modern water management in densely built areas that is cited in world literature, including Polish literature (Sendzimir Foundation 2015). The water-square was invented by De Urbanisten and Studio Marco Vermeulen as a combination of a technical engineering system with improvements to the quality of a public space. Firstly, water-squares make the money invested in water storage facilities visible and enjoyable and, secondly, it generates extra opportunities for creating environmental quality and identity in central urban spaces. The water square idea started in 2005 at the International Architecture Biennale Rotterdam, then it was officially planned in the Water Plan of Rotterdam from 2007 and finally the development was completed in 2013 (Urbanisten 2014).

The local community was engaged in the project through several intensive public workshops. Consequently, the final development includes features preferred by users. As the water-square at Bethemplein is surrounded by schools, the area was designed as a sports field and an uneven play area. The sports field is sunk into the ground and is surrounded by steps, which can also function as a stand for people to watch a game (Fig. 3). The uneven play area is also sunk into the ground. For most of the year the water-square is dry and used as a recreational space. When heavy rainfall occurs, the water-square changes its function and appearance and collects rainwater from the neighbourhood. The design ensures that the square will flood gradually. The sports field and playground are turned into ponds, where children can play in and around the water. Rainwater will stay in the water-square for a few hours until the city’s water system is back to normal (Boer 2014). This innovative solution takes into account local needs. This form of embedding resilience ensures that policy obtains community consent.

Conclusion
The consequences of climate change have already occurred and caused severe damage, especially in urban areas. And the frequency of extreme weather conditions is predicted to rise. The paper suggests that embedding urban climate resilience may be a way of protecting the future development of cities. Each city is confronted with different threats, some with an increase in heavy downpours, others with increasing droughts. Therefore, creating a resilient city is a very individual process, rooted in local conditions. However, there are some fundamental features of embedding resilience: network building, a strategic approach and project implementation. The case study of Rotterdam shows how these fundamentals work in practice. Moreover, the example of Rotterdam indicates some important characteristics of each fundamental feature: networks should be multidimensional with solid institutional and interpersonal relations, strategies should have a holistic approach and project implementation needs the engagement of all city actors (Fig. 4).

In the first place, the network should be multidimensional with institutional and relational embeddedness. All relationships may bring a certain added value and enhance flows of knowledge, innovation and creativity. Cooperation among administrative levels and different departments influences the stability and unity of policy. Moreover, less formal relations between departments may implicate creativity which can then influence policy, in Rotterdam for example – the Water Plan had roots at IBAR. Additional creativity and innovation may result from certain international activities, because many cities have similar problems. For example Rotterdam belongs to Delta Cities, which includes cities which have faced problems such as more intense storms and a rising frequency of flooding. Consequently, simple sharing of experience and actions undertaken may be inspiring. Rotterdam shares its experience with projects such as water squares and floating buildings. Finally, relations inside the city network are crucial because when all city actors are conscious and involved in the process of embedding resilience, then
visible effects are achieved. Moreover, relations within the city in Rotterdam have led to the establishment of an institution dedicated to resilience to climate change – the Rotterdam Climate Initiative, which indicates the importance of self-organisation and bottom-up activity at local level.

Secondly, a strategic approach needs to be holistic. Resilience may be focused on specific threats, but for it to be efficient – all the city structures have to be taken into account. A resilience strategy for Rotterdam is an excellent example and can be adopted by many cities. Factors related to society, business, new technology, climate change (or other threat), infrastructure, network, and resilience itself need to be included in the planning process. The strategy is obviously a general document, and often a visionary one, but it is necessary to create more specific documents and regulations. What is more, the strategy for Rotterdam was not only developed by the municipality, but also with a contribution of several organisations, initiatives and city stakeholders, which confirms the theoretical importance of social and political relations in embedding resilience.

Thirdly, project implementation as a factor in resilience building should be based on the ‘think globally, act locally’ approach, all city actors have to be engaged in creating and implementing urban developments. As the example of Rotterdam shows, despite the fact that institutions had a leading role in creating strategies and plans, almost one quarter of the projects were implemented by a local association. Additionally, businesses considered as threats to the city should act vigorously to reduce their impact. For example, in Rotterdam the port authorities do their best to reduce CO₂ emissions and to improve environmental conditions. About 10% of the developments
were implemented by the Port of Rotterdam Authority and this body showed close cooperation with the Municipality during two big projects – building incubators for innovation on RDM Rotterdam’s Campus and Plant One Rotterdam. Those projects have an indirect impact on reducing threats, both direct and indirect activities are crucial to gain comprehensive resilience. The Port of Rotterdam Authority may be treated as a role model for other actors. If the port can increase city resilience, then others can obviously do the same. It seems that the most important is an internal need to act and cooperate. Similarly with community engagement, a strong and active society leads to factual embeddedness of resilience. Connecting knowledge with society’s needs and the expertise of specialists may result in multifunctional and innovative solutions that are very likely to change problems into, not only solutions, but also opportunities.

REFERENCES


