Conference Proceedings – Short Paper

Applying the adaptation pathway approach to increase resilience to flooding: experiences and outlook from the city of Bilbao

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Abstract: Flooding is a well-known impact, which cause nowadays several problems ranging from economic loses to productivity reduction and deaths. Moreover, IPCC´s (2014) projections foresee coastal flooding as one of the main global impacts. Having this context, specific governance models are required to adapt and enhance resilience of the affected territory. In this regard, adaptation pathway emerges as an innovative and flexible approach which foster an iterative and adaptive governance and address the climate uncertainty challenge. This approach has previously been addressed in different case studies, which represent different contexts: heat, flood and water supply pathways in London; heat adaptation pathway in Antwerp; or flood adaptation pathways in Thames Estuary, Rhine-Meuse delta, Lake IJssel and New York. Looking to these studies and the experience from the city of Bilbao (further explained in this paper) it can be concluded that the adaptation pathway is a good approach to be applied at city or sector level and for analyzing different impacts. But, the same studies also detected the needs for further research: in the assumptions made for the threshold and tipping point identification (which served for the adaptation objectives definition); or the estimation of the effectiveness and co-benefits as well as implementation conditions and timeline of the measures which enhance the resilience.

Keywords: Climate change adaptation, decision support, uncertainty, risk management, pluvial flooding

1. *Policymaking in the face of uncertainty about the future*

Conventionally, policymakers in the same way as society, have addressed problems following a similar process to Newton's third law, action-reaction. That is, once the problem has been arisen a solution is sought. More recently more refine planning strategies have been placed: such as "predict and act" or Static Robust Policymaking. But, are these strategies adequate when planning urban adaptation to Climate Change? Probably not because future is uncertain and the nature of cities is complex. Moreover, uncertainties rise from cascading effect. Despite this, decision makers have to act. In the light of climate uncertainty and urban complexity, dynamic adaptive policymaking is being explored and developed, where various future alternatives are put on the table and depending on the evolution of the problem the alternative is reinforced with another set measures, modify or even delayed.

So, which dynamic adaptive policymaking do we use for Adaptation to Climate Change in Urban Systems? Despite various options are available[1] we will present what we consider a flexible methodology with multiple advantage: The Adaptation Pathway Methodology.

2. *What is an Adaptation pathway?*

The projections envision more periodic intense or extreme climatic events in Europe due to climate change. Thus, governments need effective ways to protect urban environment and population, as well as the natural environment. Adaptive policymaking is an approach for designing policies under uncertainty. Adaptation pathway is a type of adaptive policymaking, which presents different flexible adaptation scenarios that can be explored and implemented dependent on how climate and its impacts evolve. Thus, it is a way to deal with a complex and uncertain problems rather than providing a definitive answer to that problem at the outset.

What does make the Adaptation pathway unique?

Five features characterized, and distinguished adaptation pathways compared to other planning methods:

- Threshold analysis as impact assessment. A critical threshold is reached when a situation results untenable or the society perceives as undesirable[2].

[1] Warren Walker, Marjolijn Haasnoot, and Jan Kwakkel, 'Adapt or Perish: A Review of Planning Approaches for Adaptation under Deep Uncertainty', *Sustainability*, 5.3 (2013), 955–79 <https://doi.org/10.3390/su5030955>.

[2] Saskia E. Werners and others, 'Thresholds, Tipping and Turning Points for Sustainability under Climate Change', *Current Opinion in Environmental Sustainability*, 5.3–4 (2013), 334–40 <https://doi.org/10.1016/j.cosust.2013.06.005>; T. Reeder and N. Ranger, 'How Do You Adapt in an Uncertain World? Lessons from the Thames Estuary 2100 Project', in *Expert Perspectives Series Written for the World Resources Report 2010–2011.* (Washington DC, 2010) <http://www. worldresourcesreport.org/files/wrr/papers/wrr_ reeder_ and_ ranger_uncertainty.pd>.

- Adaptation tipping point (or turning point). Determines a point where climate changes irreversibly ("points of no return"), and thus, when a threshold value is reached[3].

- Appraisal. The values by which adaptation options will be ranked are, in most cases, the environmental, institutional and economic factors[4]. These factors help sequencing the adaptation options over time.

- Timing. The adaptation option implementation timing (combining distinct periods: mid-term and other long)[5].

- Flexibility, which makes it suitable under high uncertainty conditions[6]

These unique selling points are structured in four main steps (Figure 1) which cover step 3 (Identification of adaptation options) and 4 (Assessment and selecting adaptation options) of the Urban Adaptation Planning Support Tool[7].

Figure 1. (a) The steps followed in an adaptation pathway approach, applied within BILBAO Case Study

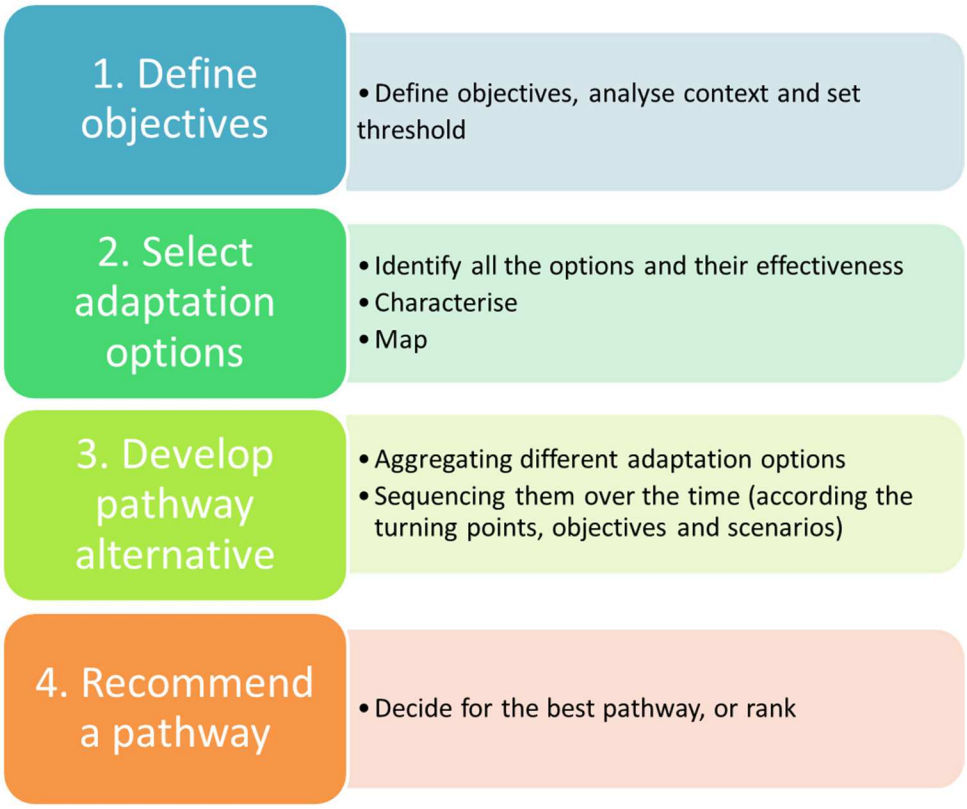
[3] Jaap CJ Kwadijk and others, 'Using Adaptation Tipping Points to Prepare for Climate Change and Sea Level Rise: A Case Study in the Netherlands', *Wiley …*, 2010 <http://onlinelibrary.wiley.com/doi/10.1002/wcc.64/full>; Walker, Haasnoot, and Kwakkel; Nicola Ranger, Tim Reeder, and Jason Lowe, 'Addressing "Deep" Uncertainty over Long-Term Climate in Major Infrastructure Projects: Four Innovations of the Thames Estuary 2100 Project', *EURO Journal on Decision Processes*, 1.3–4 (2013), 233–62 <https://doi.org/10.1007/s40070-013-0014-5>; Marjolijn Haasnoot and others, 'Dynamic Adaptive Policy Pathways: A Method for Crafting Robust Decisions for a Deeply Uncertain World', *Global Environmental Change*, 23.2 (2013), 485–98 <https://doi.org/10.1016/j.gloenvcha.2012.12.006>.

[4] Nurrohman Wijaya, 'Climate Change Adaption Measures in the Coastal City of Semarang, Indonesia: Current Practices and Performance', *Journal of Regional and City Planning*, 26.1 (2015), 28–42; J. D. Ford and L. Berrang-Ford, 'How to Track Adaptation to Climate Change: A Typology of Approaches for National-Level Application', *Ecology and …*, 2013 <http://seachangecop.org/sites/default/files/documents/2013 09 RA - How to Track Adaptation to Climate Change.pdf>; Judith Klostermann and others, 'Towards a Framework to Assess, Compare and Develop Monitoring and Evaluation of Climate Change Adaptation in Europe', *Mitigation and Adaptation Strategies for Global Change*, 23.2 (2018), 187–209 <https://doi.org/10.1007/s11027-015-9678-4>.

[5] Edmund C. Penning-Rowsell and others, 'A Threatened World City: The Benefits of Protecting London from the Sea', *Natural Hazards*, 66.3 (2013), 1383–1404 <https://doi.org/10.1007/s11069-011-0075-3>.

[6] Ranger, Reeder, and Lowe.

[7] https://climate-adapt.eea.europa.eu/knowledge/tools/urban-ast/step-0-0



(b) Authors´ elaboration within RESIN Project (1)

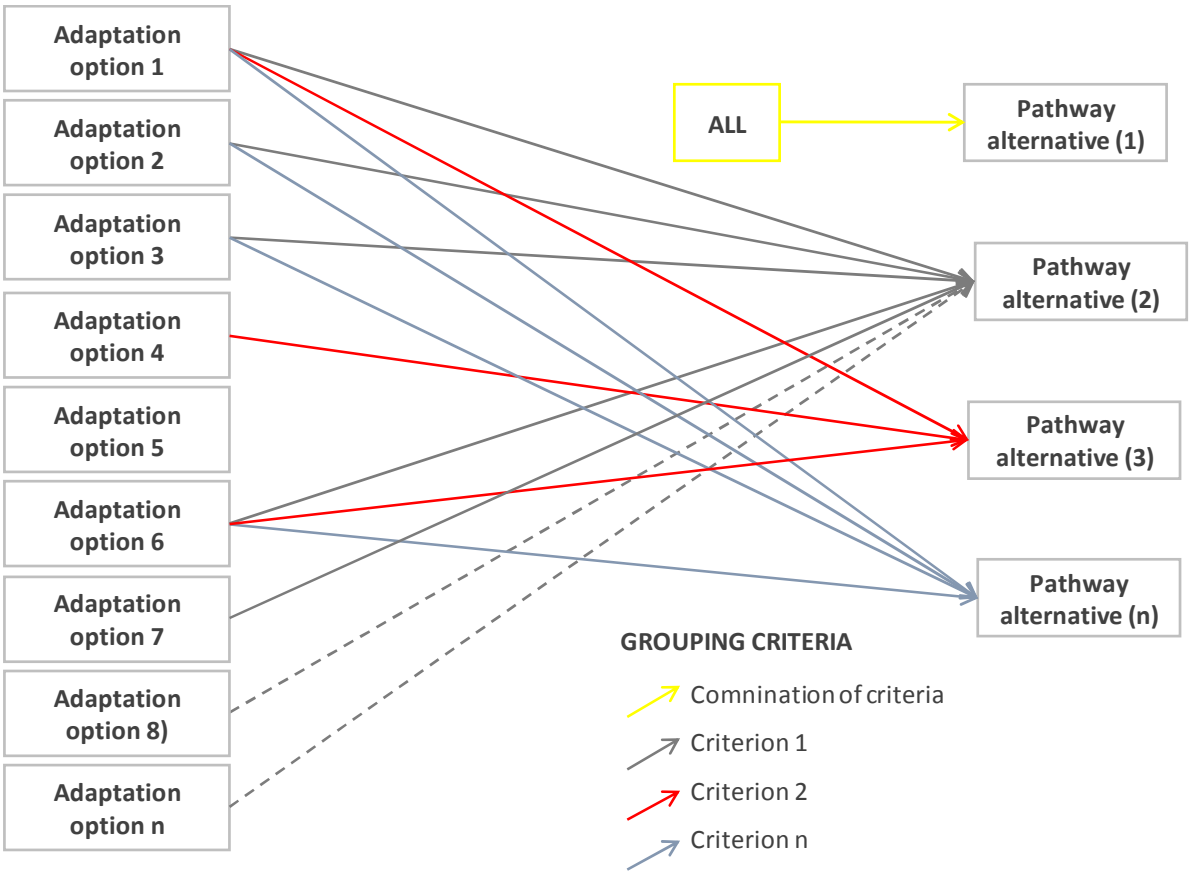
Furthermore, adaptation pathway methodologies incorporate three vital points compared to other methodologies:

1. Aggregation of adaptation options (Figure 2), that is to build set of adaptation options which are called adaptation pathway alternatives

2. Assessment of effectiveness to overcome the threshold (semi-quantitatively or quantitatively)

3. Sequence the adaptation options (see example of a pathway design in Figure 3)

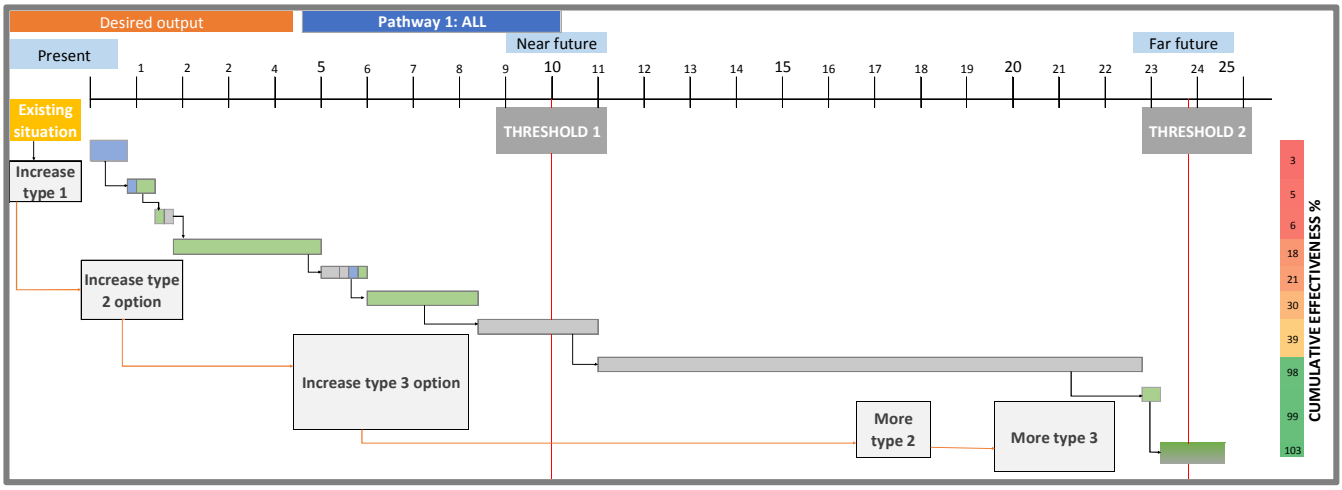
Figure 2. (a) Example of adaptation Pathway alternatives for heat waves



(b) Authors´ elaboration[8] (2)

Figure 3. (a) Example of city level adaptation sequence pathway. Adaptation option bars are correlated to their effectiveness. Cumulative effectiveness of the pathway is presented in the vertical axis.

[8] Inspired in: M. Mendizabal and N. Peña, 'Transition Reports for the Selected Case Studies' (This project has received funding from the European Union's Seventh Programme for Research, Technological Development and Demonstration under Grant Agreement No. 308497 (Project RAMSES), 2017).



(b) Authors´ elaboration (3)

3. Experiences and outlook of applying the adaptation pathway approach in the city of Bilbao

To date, the different adaptation pathway works have shown that the methodology is able to support the cities into the decision-making (addressing flood risk, sea-level rise and hurricane in the Thames Estuary, Rhine-Meuse delta, Lake IJssel and New York; heat, flood and water supply pathways in London; and heat adaptation pathway in Antwerp). It can provide, as in the case of Bilbao, a roadmap with adaptation options to be implement in a long-term time horizon. It has the added value that it gives information about how the cities reach progressively the objective. Furthermore, it may give the implementation or economical effort intensity in time slots. Therefore, a city can plan an incremental and transformative adaptation thinking on small adaptation projects.

The work carried out in Bilbao presents three added-value points and a challenge to the methodology (see Point 4):

Co-creation

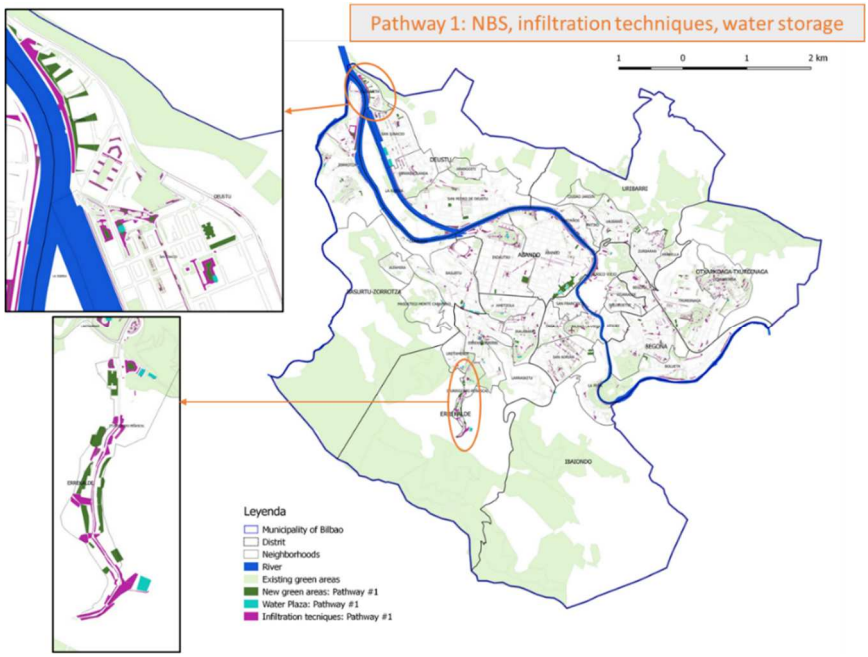
The case study of Bilbao highlighted the importance of supplementing the adaptation pathway with a **co-creation** process between the research institute and the city, for the purpose of aligning the city´s views and needs with the adaptation pathways. The co-creation activities allow to customize and adjust the methodology to the local context. As a result of the co-creation process an **effective information** was achieved within the stakeholders of the city of Bilbao. A deeper knowledge on the hazards, potential implementation sites for the solutions and methodologies to increase the climate resilience was gained. A second major gain of the co-creation process is the increase of **engagement** and **acceptance** of the outcome of the pathway from the local authorities which are the owners of the pathway and the ones implementing it.

Mapping of adaptation options

Furthermore, it is worth mentioning that urban planning is a key local policy for the development and application of adaptation pathways in cities. At the early stage of the co-creation process we

asked the urban planning department of Bilbao: Is it adequate to present the overall effectiveness of adaptation pathways alternatives? The answer was NO, as in first instance, urban planning should inform and even determine **potential adaption options mapping** (Figure 4). Especially for pluvial flooding. It may not be as clear as for fluvial flooding where the adaptation options should be implemented. The potential implementation sites should be identified together with the Urban Panning Department of the city considering existing urban development planning instruments.

Figure 4. (a) Mapping of adaptation options considered in Pathway alternative 1 (Infiltration techniques, nature-based solutions and water storage solutions). A zoom into new developments, Elorrieta and Peñascal, have been made in order to better visualize the different adaptation options



(b) Authors´ elaboration (4)

Appraisal. Comparison between effectiveness assessment

Effectiveness assessment together with threshold and tipping points identification may be crucial for the successfulness of the adaptation pathway methodology.

In the case study of Bilbao effectiveness towards pluvial flooding was assessed by studying the infiltration capacity rate associated to adaptation options. However, two different options were presented: a semi-quantitative approach where literature effectiveness is used while quantitative approach is based on modelling. So, which approach is best? It depends.

Having as secondary aim of the work exploring how the step-by-step methodology for pathway design can be simplified or used when modelling is not feasible, it was concluded that this may be possible thanks to the semi-quantitative approach. The work carried out in the case study of Bilbao demonstrated that the semi-quantitative is a good approach to obtain an adaptation pathway with less effort and resources. This methodology despite being a rougher approach it will aid presenting the most plausible pathway alternative and help rank the different pathways based on their

effectiveness to reduce the impacts of a climatic hazard (heavy rains in this case). The ranking of pathways obtained by this approach are the same as obtained with the quantitative approach in Bilbao. This proof the validity of the semi-quantitative approach.

However, the semi-quantitative approach does not consider the orography of the terrain and the exact location of the adaptation actions as the quantitative methodology. Thus, the modelling helps to visualize the development of pluvial flooding over the domain and assists in the identification of areas where problems with flooding may arise. It also provides a spatial effectiveness of the adaptation options. And comparing with the semi-quantitative approach, it gives more accurate effectiveness results (which considers local context). But the quantitative approach requires more effort and it is time consuming.

Threshold and tipping point identification

The co-creation states the need of determining the threshold together with stakeholders (as they need to accept the threshold). In the case of Bilbao, the two threshold values were set after few discussions with the Bilbao´s stakeholders. Selecting several threshold values allowed developing a pathway which it is robust enough to handle different scenarios.

The tipping point identification requires the use of climate and socio-economic scenarios. These scenarios allow identifying when a threshold value is reached. In Bilbao case, the objective agreed with Bilbao´s City Council was to increase the infiltration capacity under heavy short rain events. This objective requires having sub-daily precipitation information which was possible for the past, but it was not possible to have it for the future. Therefore, the pathway design in Bilbao is more focused in finding adaptation options that reaches the threshold rather than identifying tipping points.

4. Challenges for the further development of the approach

As in all problem-solving methodologies there is no solution exempt of disadvantages or challenges. Adaptation pathways can suffer from lack of effectiveness data or the timely detection of tipping points[9]. These challenges are related to the methodology itself. However there are other challenges common to all urban decision-making assisting tools or methodologies: i) the natural resistance to take into consideration "new" high uncertain factors into policy-making such as climate change and ii) the retention of commitment of all local (or regional/national) authorities and stakeholders. These last two points are highly linked.

In the case study of Bilbao, the identified major challenge was related to tipping points. Further work on tipping points determination methodology is needed when climatic scenarios are not present or in the absence of precise policy goals.

[9] Pieter Bloemen and others, 'Lessons Learned from Applying Adaptation Pathways in Flood Risk Management and Challenges for the Further Development of This Approach', *Mitigation and Adaptation Strategies for Global Change*, 2017 <https://doi.org/10.1007/s11027-017-9773-9>.

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Conflict of Interest

The authors declare no conflict of interest