Ref. Ares(2019)4118127 - 28/06/2019

Horizon 2020 Societal challenge 5:
Climate action, environment, resource
efficiency and raw materials

BINGO

Bringing INnovation to onGOing water management –

a better future under climate change

Grant Agreement n° 641739, Research and Innovation Action

Deliverable number:	D5.6
Deliverable name:	Exploitation of adaptation strategies beyond the research sites
WP / WP number:	WP5 – Developing risk treatment and adaptation strategies for extreme weather events
Delivery due date:	Project month 48 (30/06/2019)
Actual date of submission:	28/06/2019
Dissemination level:	Public
Lead beneficiary:	KWR
Responsible scientist/administrator:	Henk-Jan van Alphen
Estimated effort (PM):	1,1 PM (total)
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Estimated effort contributors (PM):	KWR: 1PM; Intersus: 0,1PM
Internal reviewer:	WP leader Henk-Jan van Alphen (KWR), Coordinator

Changes with respect to the DoA
Not applicable

Dissemination and uptake
Actors at potential target locations, who are looking to learn from the BINGO project to improve their local decision making processes for prioritizing adaptation measures to deal with the risks associated with climate change, could use this deliverable to direct their learning process. National governments wanting to identify and stimulate new target sites beyond the BINGO research sites to apply the BINGO approach could also use this deliverable. The partners within the project could use this deliverable to inform and focus their activities aimed at sharing the project outcomes towards supporting better informed decision making by authorities and companies in the EU.

Short Summary of results
The main question to be answered in this deliverable was: Which adaptation measures, knowledge, information, data and/or tools generated in the BINGO project are potentially transferable beyond the six BINGO research sites? A succinct answer to this question is that (1) some of each type of BINGO outcome is theoretically transferrable, and that (2) the decision support methods and tools that were used to prioritize adaptation measures are both highly transferrable and particularly useful for potential target locations beyond the BINGO research sites.

This deliverable is structured with a description of the different types of project outcomes that could be transferred, followed by a discussion of what transfer would involve for each outcome type. The 44 adaptation measures included in the BINGO Portfolio of Adaptation Measures have 'conceptual generality', because they are formulated as abstract concepts: This makes them highly transferable. Modification of these adaptation measures at the research sites, to deal with the site-specific risks and conditions, resulted in better fitting and less transferable products. The BINGO approach that was used to prioritize and specify these adaptation measures, including stakeholder involvement in communities of practice, is widely transferable beyond the project. Partners at some of the research sites have intentions to apply this approach at new locations in the near future.

Evidence of accomplishment
Deliverable report D5.6

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1. INTRODUCTION

This D5.6 report is the final deliverable of Work Package 5 (WP5) of the BINGO project. A large part of WP5 was directed at providing support to decision-makers on the local level at the six research sites. These decision-makers worked together with the local stakeholders to plan the implementation of adaptation measures to address the expected impacts of extreme weather events due to climate change. The research in WP5 was also meant to assist these local actors in dealing with the policy and governance issues associated with implementing the chosen adaptation measures.

In addition to the site specific objectives and activities, WP5 work included developing methodologies to support and facilitate the application of lessons learned in the BINGO project to situations, regions, and communities beyond the research sites. This work resulted in, for example, the (online) portfolio of risk management and adaptation strategies. In this D5.6 report we discuss the potential for transferring the BINGO adaptation measures, knowledge, and tools more explicitly. Transferability depends on various attributes of the adaptation measures, knowledge, and tools themselves, as well as diverse contextual conditions: A gondola that works perfectly in Venice may be useless in some Middle Eastern cities (Figure 1). Each of these aspects is discussed in the following chapters before coming to conclusions about transferability.

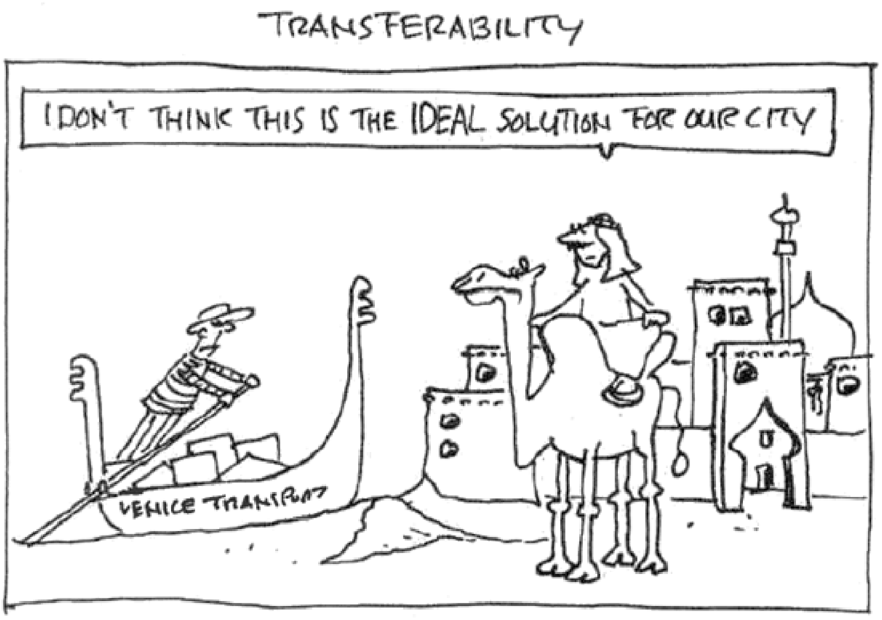

Figure 1: Transferability (Dziekan et al., 2013).

2. INTRODUCTION TO THE DELIVERABLE

2.1. Description of Deliverable 5.6

Deliverable 5.6 is a report on the “exploitation of adaptation strategies to extreme weather events beyond the research sites” (BINGO Grant Agreement, 2015). This report elaborates on the locally planned adaptation strategies to extreme weather events, promoting the transfer of results to different regions/countries beyond the six research sites. The tools used and the adaptation measures that are deemed to be suitable depend on the site specific situation. Which adaptation measures, knowledge, and tools might be applied in other regions with similar challenges? Answering this question, which is first explicated in the following section, is the main aim of Deliverable 5.6.

3. QUESTIONS TO BE ANSWERED

3.1. Main question

Which adaptation measures, knowledge, information, data and/or tools generated in the BINGO project are potentially transferable beyond the six BINGO research sites?

3.1.1. Sub-questions

- What BINGO outcomes could be transferred?
- What would transfer involve?
- How might transferability be influenced by attributes of adaptation measures?
- How might transferability be influenced by contextual conditions?
- Which regions/countries are experiencing similar problems and risks?
- Which regions/countries have similar contextual conditions?

4. TRANSFERABILITY BEYOND THE RESEARCH SITES

4.1. What BINGO outcomes could be transferred?

Horizon 2020, the EU Framework Programme for Research and Innovation (2014-2020), is meant to generate diffusion of innovations in the economy, generating jobs, growth, and investments. The research is meant to contribute to tackling societal challenges and improving the uptake of solutions. And it is also meant to support better informed decision making by authorities and companies in the EU.

The approach that was designed for the BINGO project, with close collaboration between local researchers and stakeholders to assess potential risks and impacts before developing and planning adaptation strategies, was applied at six research sites throughout Europe. This approach resulted in well informed local decisions and local knowledge. In addition, researchers developed more generic knowledge through analysis and synthesis of results on a macro-level; that is, across the six research sites. There is thus a wealth of knowledge about how to prioritize climate adaptation measures in a scientifically sound manner with broad support from stakeholders. In addition to learning from what works, or what was found to work at the BINGO research sites, it is also interesting to consider what might be transferable regarding lessons learned about what didn't work. Did the partners experience failures that others can learn from so as not to make the same mistake twice?

In response to the question of what BINGO outcomes could be transferred, four types of transferable outcome have been specified:

1. the BINGO approach to prioritizing climate adaptation measures
2. the (concrete) adaptation measures
3. decision support methods and tools
4. the data, information and knowledge gained through research and by the local stakeholders

These four types of transferable BINGO outcomes are detailed in the following sub-sections.

4.1.1. The BINGO approach

The BINGO project involved: (1) downscaling climate change projections to particular research sites; (2) assessing the expected impacts of future extreme weather events; (3) developing a portfolio of possible risk treatment and adaptation strategies; (4) local stakeholders prioritizing risk treatment and adaptation strategies to be applied locally; (5) calculating the expected risk reduction levels and impacts of the prioritized measures. These five steps were carried out according to the 'community of practice' approach, which entailed active involvement of stakeholders via a clearly structured series of workshops. The guidelines for this community of practice approach are described in deliverable 6.2. In addition to the communities of practice, a digital platform was used for knowledge exchange during periods between the workshops.

4.1.2. The adaptation measures

The 44 adaptation measures included in the 'BINGO Portfolio of Adaptation Measures' are of a conceptual nature; that is, they are not tied to a particular people, locations, and times (Glaser, 2007). Even the most concrete, infrastructural measures, such as Combined Sewage Overflow Treatment (CSO treatment), have been formulated as 'higher level' concepts. To use the example of 'CSO treatment', the type of treatment technology and its location (at the source, at the plant, or where CSO water is discharged) is unspecified. That is exactly what makes these higher level concepts generic, and thus transferable. It is needless to say that a generic measure such as 'water saving' is basically feasible everywhere, whereas a transfer pipeline only works in catchment areas that have more than one reservoir. The specific biophysical preconditions for the measures are briefly discussed in section 4 of this deliverable.

The generic adaptation measures that are included in the BINGO Portfolio were not invented or conceived of in the BINGO project. The fact that the research partners and local stakeholders were able to consider and adopt or reject these existing concepts is proof of their transferability. In fact, this type of transfer is more a question of whether the concept can be codified and communicated (See 4.1.4. Data, information, and knowledge). But the fact that these higher level concepts are transferable is not an outcome of the BINGO project. Furthermore, the BINGO project was not designed to demonstrate the transferability of these concepts/measures. If this had been the case then a particular measure would have been implemented at diverse locations and the researchers would have studied the effectiveness of the measure across locations and over time. In answer to the question of what BINGO outcomes could be transferred, it would thus be illogical to focus on the 44 adaptation measures themselves. The BINGO project may have improved the transferability of these concepts by raising awareness about them and priming actors at potential target sites to take some lesser known concepts into consideration.

4.1.3. Decision support methods and tools

Besides the overall approach on the project scale, the BINGO project partners also developed and applied methods for each of the component steps. The 'Risk Management Approach' (Deliverable 4.1-4.6) that was developed to support adaptation to climate change is a noteworthy example. In addition, the decision support methods such as cost-benefit analysis and multi criteria analysis (MCDA) in combination with cost-effectiveness analysis, are useful for comparing and prioritizing adaptation measures in any climate change adaptation study. A precondition for the transferability of these methods is that the target site has defined a discrete and feasible set of potential adaptation measures beforehand. The BINGO Portfolio provides a good starting point for satisfying this requirement.

In addition to the decision support methods, the BINGO project also applied Water Cycle Safety Planning (WCSP), MCDA and road-mapping methods. These methods were adopted from a foregoing EU project (TRUST), which is in itself evidence of their transferability. The WCSP concept consists of hazard analysis, risk assessment (WP2, WP3, WP4) and risk adaptation (WP5). These methods and tools, specifically designed to work out adaptation strategies with stakeholders, are excellent communication tools that support discussions and decision making. The combination of decision support methods, which is as yet unique to the BINGO project, could be applied at any other locations where there is funding and support for exploring various strategies and solutions before prioritizing a particular one. This combination of decision support methods proved to be useful at each of the six research BINGO sites.

4.1.4. Data, information, and knowledge

The BINGO project collated, ordered, used and generated data, information, and knowledge both locally, by stakeholders and local researchers, and on a macro-level, by researchers. This data, information and knowledge was generated and exists in both the subjective domain (inner phenomena in the minds of individuals) and external phenomena in the universal domain (Zins, 2007). For this report on transferability we focus on data, information, and knowledge that was gained empirically and internalized, through the experience of the case studies, but which can also be to codified as information (e.g. in a written report) and communicated with a recipient (e.g. the reader). Such knowledge is commonly referred to as “lessons learned”. Tacit knowledge that cannot be codified into information, for example knowing the feeling of catching a snowflake on your tongue, is excluded.

Research in the BINGO project included the collection and integration of data and information from various disciplines. Climate data, economic data, and spatial data, for example, were all collated in spreadsheet software and GIS tools. This data was also used as input for hydrological models and statistical models to extrapolate data about future conditions, including uncertainty calculations, and to downscale higher/aggregate level data. These operations all generated more data and information. The BINGO project also produced tools, such as the precipitation guided conditional stochastic weather generator (D2.8), that perform operations on this data to generate more locally relevant datasets.

In addition to the data, the project partners working in 7 work packages, produced a great deal of information in the form of milestones, deliverables, and other (scientific) publications. Most of this information was recorded in (online) text documents, diagrams, and maps. Some information was also recorded in other media, such as videos. The project partners also exchanged information and opinions with other stakeholders during workshops and meetings, generating new knowledge; information about which is also documented in text documents. Some reports primarily serve to record information, such as the D5.2 report that gives a summary of the reports of the first two series workshops of the BINGO project. Other reports, such as D5.1, provide guidance to readers beyond the research sites and explain how to use certain tools, such as the online Portfolio of adaptation measures. In the following chapter, on what transfer would involve, it is necessary to distinguish between these different types of data, information, and knowledge.

4.2. What would transfer involve?

In discussing transferability are we referring to (1) expansion, (2) replication, and/or (3) spontaneous diffusion? (Van Winden, 2016). In the context of BINGO, expansion would mean scaling up the case study within the region of a single research site, under the assumption that similar contextual conditions are locally present. This would be a welcome development in the future, however it is not the main goal of this European project. Spontaneous diffusion involves the spread of new ideas or practices largely of their own accord (Van Winden, 2016). This is also a welcome phenomenon, but not one that can be steered since it is essentially unintentional. The fact that the BINGO project involved diverse actors throughout Europe, and that the results are openly available online, is meant to facilitate such diffusion.

In this report we focus on transferability in terms of 'replication', as distinct from up-scaling (see Figure 2). Replication involves the deliberate decision, based on the experience at the original research site, to implement the same adaptation measure with a new group of actors at another location. It may involve some of the original partners, especially if the replication project takes place within the same country, but might also involve an entirely group with a different culture. The context is more important for replication than for expansion.

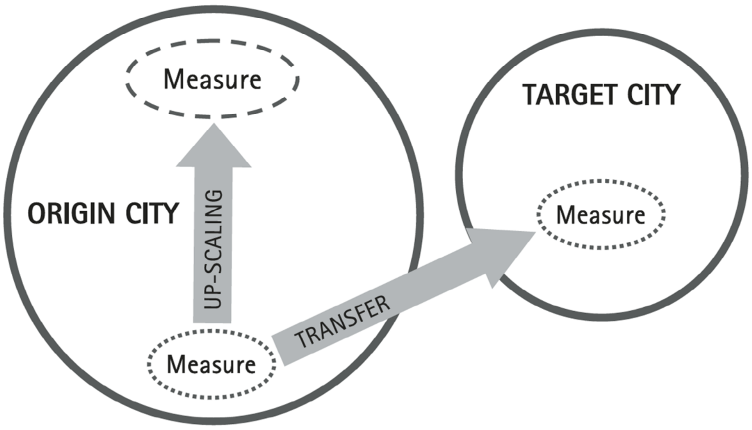

Figure 2: Distinction between up-scaling and transferability (Dziekan et al., 2013).

4.2.1. Theoretical perspectives on transferability

There are various theories about, and models for, the transferability of solutions that differ depending on which philosophical orientation is taken. When it comes to the transferability of measures it is important to make the distinction between feasibility and transferability, although these terms are often used interchangeably. Feasibility studies involve appraisals of the process of implementing the measure to determine whether the measure could be applied in the local setting. In contrast, an assessment of transferability is more concerned with the effectiveness of the measure; that is, whether the outcomes of the measure are likely to be similar to those seen in the case study (Wand, Moss, & Hiller, 2005).

Dziekan et al. (2013) categorically state that "a precondition for transferability is the successful implementation of a measure.". If we were adopt this stance in this D5.6 report then none of the measures that have been designed and evaluated in the BINGO project would be demonstrably transferable, because they have not been implemented yet, let alone evaluated. In BINGO, the projected outcomes of the measures have been simulated in terms of anticipated risk reduction, using models. But this does not constitute empirical evidence of outcomes. This D5.6 report is thus a theoretical assessment of potential transferability, and not an empirical evaluation (Moon et al., 2016).

According to Guba (1981) transferability refers to the question of "How can one determine the degree to which the findings of a particular inquiry may have applicability in other contexts with other subjects." Are the BINGO measures likely to work with other people, in different locations, and at different times? Moon et al. (2016) claim that qualitative research studies are not typically generalizable because they tend to relate to a small number of contexts or individuals. They go further to claim that it is often "not possible, or desirable, to demonstrate that findings or conclusions from qualitative research are applicable to other situations or populations" (Moon et al., 2016). Schofield (2002) agrees that there is a widely shared view that the generalizability of qualitative research is: "unimportant, unachievable, or both." Considered from this stance, transferability might involve , for example, developing new conceptualizations via a single case study to challenge currently accepted norms.

Culturally specific understandings and interpretations of a case study are inevitable (Chiang & Birtch, 2007; Holden, 2002). One response to this fact might be to aim for "user generalizability", whereby the readers or end-users are asked to find "relevant patterns” in the detailed “thick descriptions” of the case studies (Misco, 2007). On the other hand, Chametzky et al. (2013) argue that “when people can relate to a theory (or its elements), because of its grab and ‘conceptual generality’, then the theory has a certain amount of generalizability outside the substantive area.” The idea of ‘conceptual generality’ is that the theory must be conceptual rather than descriptive, thus releasing the concept from its ties with particular people, locations, and times (Glaser, 2007). To satisfy this purpose the BINGO deliverables would need to identify “underlying uniformities” in the case studies to formulate higher level concepts. In some sense, the BINGO approach to helping stakeholders at six diverse locations to prioritize risk treatment and adaptation strategies is an example of a ‘higher level concept’ of this type. Additionally, the portfolio of adaptation measures is populated with technologies and concepts of this type (e.g. ‘Flood Insurance’). The BINGO project was not, however, designed to demonstrate the transferability of these concepts/measures. If that were the case then a single measure would have been implemented at diverse locations and the research would involve a longitudinal study to evaluate similarities and differences in the effectiveness of the measure across locations. The BINGO approach itself was implemented in this way, and after four years the six research sites realized the goal of prioritizing adaptation measures based on sound scientific research.

If we consider the knowledge, information, and data generated though the BINGO approach then the answer to the question of transferability is less clear. Advocates for “contextualized knowledge” would argue that context-free/universalist knowledge is overvalued, and that contextual sensitivity is more important (Welch et al., 2011). There appears to be a trade-off between these approaches: “The rich context that is the essence of a case study is ultimately regarded as a hindrance to theorizing. Since to theorize is to generalize away from the context, explaining and “contextualizing are regarded as being fundamentally opposed.” (Welch et al., 2011). Different scientists adopt different positions in this trade-off based on their philosophical orientation (Table 1).

In this D5.6 report the BINGO case studies are treated as ‘Contextualised explanations’ (bottom-right corner of Table 1). Causal explanations “are developed not by collecting observations but rather by digging beyond the realm of the observable.” (Collier, 1994, cited in Welch et al., 2011).

	Positivist (empiricist)	Positivist (falsificationist)	Constructionist	Critical Realist
Main advocate	Eisenhardt	Yin	Stake	Bhaskar
Nature of research process	Objective search for generalities	Objective search for causes	Subjective search for meaning	Subjective search for causes
Strength of case study	Induction	Internal validity	Thick description	Cause-of-effects explanations
Nature of causality	Regularity model: proposing associations between events	Strong causality: specifying cause-effect relationships	Causality is too simplistic and deterministic a concept	Specifying causal mechanisms *and* the contextual conditions under which they work
Role of context	Contextual description a first step only	Causal relationships are isolated from the context of the case	Contextual description necessary for understanding	Context integrated into explanation
Case study outcome	Explanation in the form of testable propositions	Explanation in the form of cause-effect linkages	Understanding of the actors' subjective experiences	Explanation in the form of causal mechanisms
Attitude to generalization	Generalization to population	Generalization to theory (analytic generalization)	Particularization; not generalization	Contingent and limited generalizations
Method of theorizing from case studies	Inductive theory building	Natural experiment	Interpretive sensemaking	**Contextualized explanation**

Table 1: Comparing four methods of theorizing from case studies (adapted from Welch et al., 2011). In this D5.6 report the BINGO case studies are treated as 'Contextualised explanations'.

Perhaps the most fitting goal concerning the transferability of BINGO outcomes is to generate "grounded understandings". This would mean making tentative apprehensions of the importance or significance of certain causes-of-effects relations, which conceptualize to the point of producing meaning without dislocating the theory from the particular (Misco, 2007). The assessments of 'risk reduction potential' related to the adaptation measures that were prioritized at the six BINGO research sites (D5.3) provide a sound basis for actors at potential target locations to develop grounded understandings of this type. The 'risk reduction potential' has been calculated by taking the specific adaptation measures and the local context into consideration. These assessments were made in a systematic way that has been communicated transparently. This means that the specific risk reduction potential that was calculated per adaptation measure for the BINGO sites is not transferable in itself, but actors at potential target locations can understand how the measures reduce risk so as to make their own judgements about the relevance and potential for their local context.

In relation to the concept of grounded understandings, it is important to make a distinction between the knowledge that may be transferred from the specific findings of one case study, versus understanding general patterns of evidence (Krizek et al., 2009). Actors at potential target locations might view the BINGO case studies in the context of many other case studies and projects worldwide to identify some general patterns. But the ten BINGO case studies alone do not include enough examples to act as a reliable basis for performing this type of synthesis. Actors at potential target locations, who are interested in implementing certain adaptation measures, need to be warned against cherry-picking case studies that fit a particular predetermined agenda or plan: "This is perhaps the biggest current problem with the use of research evidence: when practitioners use only a single source, unworried by conflicting evidence because they ignore evidence that does not agree with their position." (Krizek et al., 2009).

4.2.2. Who is doing the transferring

To understand what transfer involves it is important to consider who initiates the transfer, who realizes the transfer, and who evaluates the fulfillment of the transfer. Transferability can be viewed from the perspective of the six BINGO research sites; that is, the people who may want to share their lessons learned. Alternatively, transferability may be viewed from the perspective of the actors outside the BINGO research sites who may want to learn from the experiences in the BINGO project. Thirdly, transferability may be considered from the perspective of a third party, such as a national government, who may want to transfer solutions to a specific location within their country. In this report we focus on the ex-ante evaluation of potential transferability by people involved in the BINGO project. The section 4.2.10 of this report is intended to shift the perspective more towards the perspective of actors at 'target' locations. These actors are best placed to judge how appropriate transfer is likely to be in their own context. Many qualitative researchers agree that the reader must assess the transferability and initiate the transfer (Moon et al., 2016; Graneheim and Lundman, 2004). This requires a detailed, 'thick' description of the context and culture, data collection and analysis, which has been the case in the BINGO project.

4.2.3. Transferring the adaptation measures

Wang et al. (2005) define the process of a transferability appraisal for interventions as follows: "a list of factors that could potentially influence the intervention effectiveness should be developed first, and then the similarity of these factors between the original study setting and the local setting would be rated." We distinguish between attributes of the measures on the one hand (chapter 5), and contextual conditions on the other hand (chapter 6). There is an important difference between a measure's potential risk-reduction effectiveness and the extent to which this can be realized in the particular local context of the target site. The BINGO project did not encompass the implementation phase, so the effects of the measures have not yet been evaluated (Figure 3).

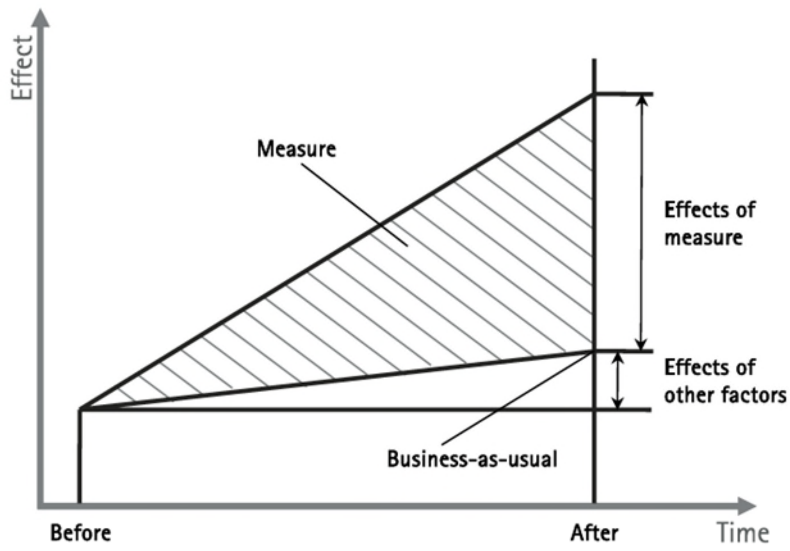

Figure 3: Evaluating the (potential) effectiveness of measures (Dziekan et al., 2013)

4.2.4. Attributes of adaptation measures

Adaptation measures have qualities or attributes that can make them more or less suitable for transferring to new locations. Just as a measures that work on a larger scale can be ineffective and/or inefficient on a smaller scale. Consider, for example, circular economy measures where the waste from one company is used as input for another company. Such measures are both context dependent and scale specific. This may also be true for some of the BINGO adaptation measures, thus limiting their transferability. The purpose of this section is to specify the attributes of adaptation measures that are likely to influence their transferability.

The BINGO Portfolio of Adaptation Measures includes 44 measures of which 24 are regulatory and financial, 15 are technological and infrastructural, and 5 are social and informational (see Figure 4). It is important to note that the number of measures per category is just a rough analysis, since the measures could have been lumped or spit in various ways. Sustainable Urban Drainage Systems (SUDS), for example, can include various concrete objects, such as green roofs, pervious pavements, bio-retention systems, swales, wetlands, soakaways, infiltration basins, etc. Alternatively, the measures could be divided into biophysical versus management categories. In this case, about one third are biophysical and two thirds are management interventions. Within the management interventions it is interesting, however, to distinguish the social and informational measures from the more traditional regulatory and financial measures, since the former are particularly dependent on the socio-political context and the current level of knowledge, thus influencing their transferability. Assessments of risk reduction potential (D5.3) found that, within the biophysical measures, those that involve 'nature based' solutions potentially result in more positive side effects than the classical infrastructure and technological measures. All of these attributes of adaptation measures make them more or less attractive to the stakeholders and decision makers at potential target sites, and also more or less transferable.

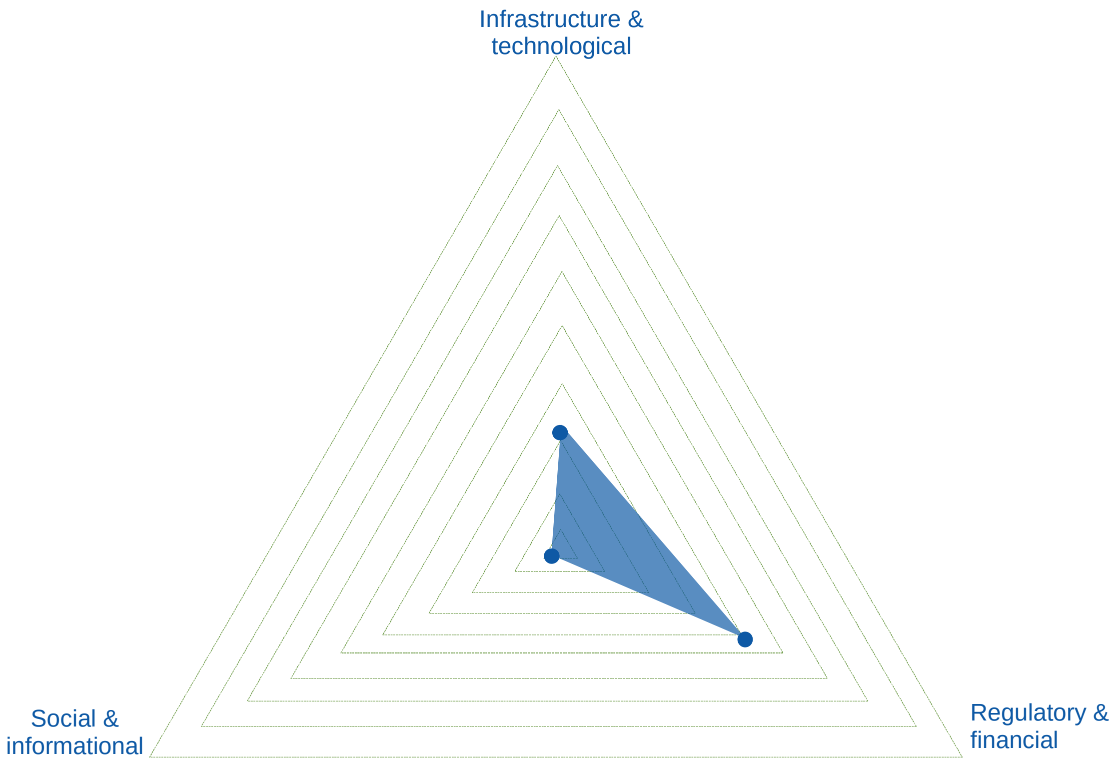

Figure 4: Categories of BINGO adaptation measures

The infrastructural and technological measures are generally more expensive than the other types (See deliverable D5.3). But since the social, informational, regulatory and financial measures tend to be more dependent on the political and cultural context (section 4.2.6), it is generally assumed that the technological and infrastructural measures are more easily transferrable. On the other hand, the technological and infrastructural measures also depend on certain contextual factors and some measures, such as CSO Treatment, involve both biophysical and management interventions. It is thus unreasonable to make categorical judgments about the transferability of adaptation measures according to whether they fall within the biophysical versus management categories (Figure 4). Even so, technological measures such as installing filtering mechanisms at inlets, water-saving equipment, modernizing infrastructure, and sewer separation are clear-cut and unambiguous, and have predictable biophysical outcomes, which makes them relatively straightforward to implement where the biophysical circumstances lend themselves to these solutions.

The adaptation measures included in the BINGO Portfolio are further categorized according to: (1) the risks that they were designed to address; (2) their specific objectives, and (3) the sectors that they were designed for. There is a fairly even spread of measures across the two risk categories: Decreased precipitation (drought) versus increased precipitation (flooding and CSO's). The transferability of measures could be influenced by the risk category that the measure is designed to address if there were to be a difference in the projected geographical spread of extreme weather due to climate change. In other words, if more locations throughout Europe are likely to be facing drought due to climate change, and less locations are projected to have increased precipitation (intensity), then the measures that are designed for dealing with decreased precipitation will be most transferable.

A rough analysis of the seasonal mean percentage precipitation change as projected by the IPPC (2013), shows that northern Europe is likely to experience an increase in precipitation whereas southern Europe is likely to increase a decrease in precipitation (see Figure 5). This analysis provides, however, no indication about extremal episodes such as the intensity of the precipitation events, droughts. or heat waves. These events have been modelled, downscaled and mapped for several research sites in the BINGO project (see BINGO deliverables WP2). The site specific projections of extremal episodes have limited geographic coverage and are too detailed for evaluating the transferability of the measures across Europe. In general it can be concluded that there is a need for measures that address both precipitation extremes, and that the transferability of these measures is unlikely to be influenced by the specific risk category that the measure is designed to address.

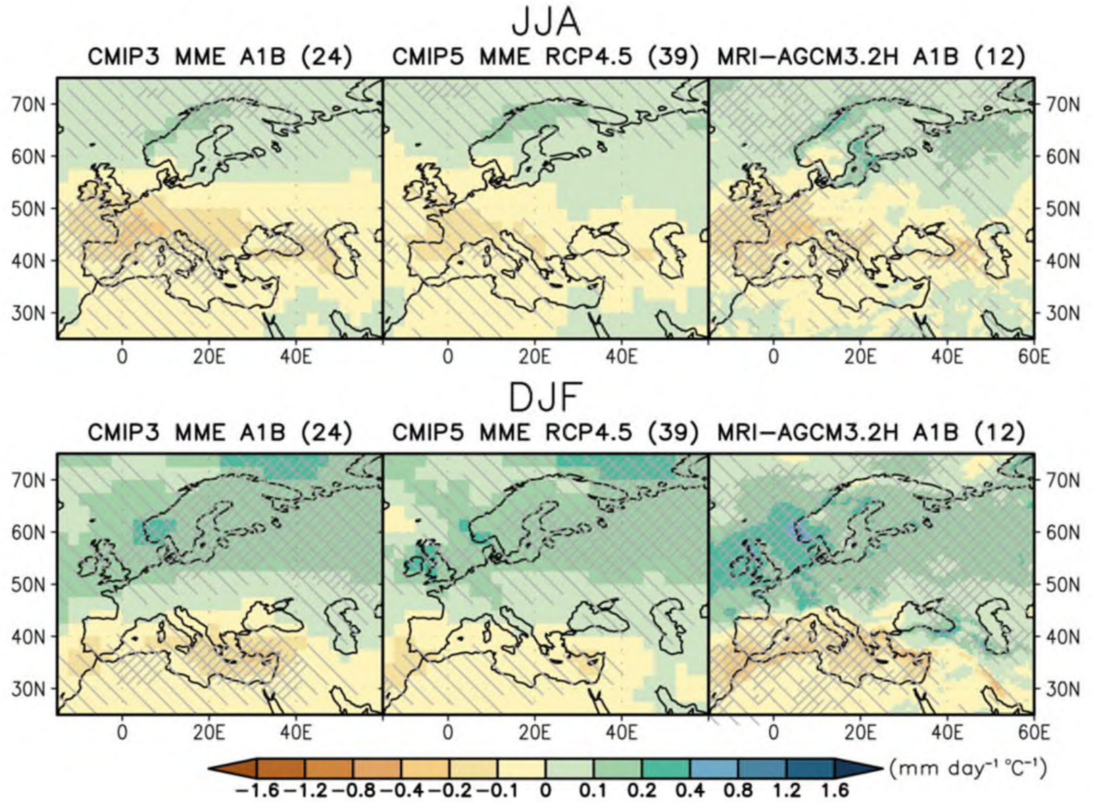

Figure 5: Maps of precipitation changes for Europe and Mediterraneian in 2080-2099 with respect to 1986-2005 in June to August (above) and December to February (below) in the SRES A1B scenario with 24 CMIP# models (left), and in the RCP4.5 scenario with 39 CMIP5 models (middle). Right figures are the precipitation changes in 2075-2099 with respect to 1979-2003 in the SRES A1B scenario with the 12 member 60km mesh AGCM3.2 model. IIPCC, 2013.

In addition to the two main risk categories (droughts versus flooding and CSO), researchers have defined thirteen 'specific objectives' as a framework for the BINGO Portfolio of Adaptation Measures:

1. Reduce private water use
2. Optimize water allocation
3. Reduce agricultural abstractions
4. Optimize water management
5. Improve water quality
6. Alternative water resource
7. Debris reduction
8. Increase retention/drainage
9. Reduction of CSO impact on water quality
10. CSO emergency response and recovery
11. Erosion control

12. Increase recovery capacity
13. Flood risk reduction

The transferability of each adaptation measure obviously depends on the number of potential target sites that are facing risks due to climate change which may be reduced by meeting the ‘specific objectives’ associated with that measure. As with the assessment of risk categories above, it is unlikely that the transferability of the measures that are included in the BINGO Portfolio will be limited by a lack of ‘target sites’ with relevant risks and shared objectives. The balanced spread of measures across each of the categories means that practically all potential target sites will be able to find adaptation measures in the BINGO Portfolio that deal with the water related climate change risk reduction objectives that they have set. It is perhaps needless to say that each adaptation measure has been designed to realize certain objectives, and if these objectives are not shared between the origin site and the target site then the measure will not be transferable.

In addition to the types of risks, the BINGO Portfolio of Adaptation Measures distinguishes seven sectors that the measures were designed for: (1) Water Resource Management; (2) Agriculture (drought); (3) Public Water Supply (drought); (4) Agriculture (flood); (5) Flood Risk Management; (6) Public Water Supply (flood); (7) Urban Drainage. There is a relatively even distribution of adaptation measures across each of these sectors, with many measures being applicable to more than one sector. All countries throughout Europe require public water supply and urban drainage, which makes the measures related to these sectors highly transferable. There is greater diversity between countries in Europe, however, as regards the size, intensity, economic importance, and nature of the agricultural sector. Focusing on the geographical area (Figure 6), it is clear that countries such as Spain and France have greater areas of agricultural land than other countries, such as Norway. But if we zoom in on Spain and France we also see significant differences in the type of agriculture, with for example Spain producing more fruits, vegetables, and horticultural products and France producing more cereals and wine. A country such as the Netherlands also produces a high output of vegetables and horticultural products on a relatively small geographical area (high intensity). This diversity across Europe means that the adaptation measures that were specifically designed for the agricultural sector are relatively less transferable than measures that concern, for example, public water supply.

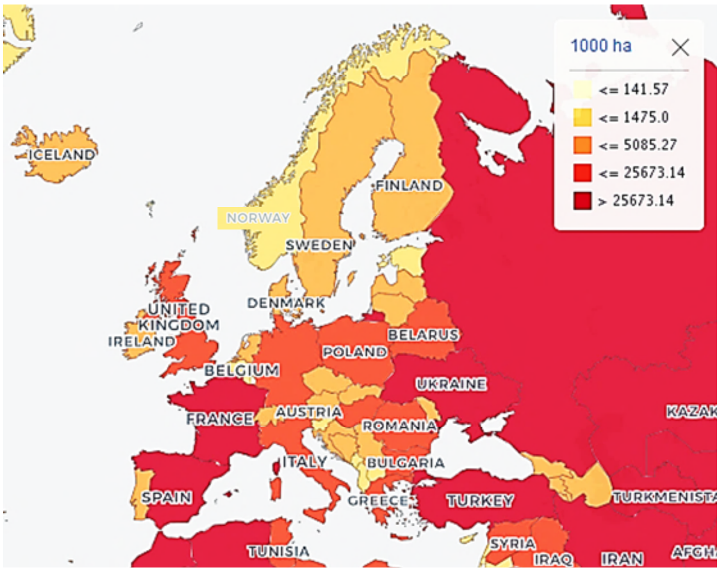

Figure 6: Map of Agricultural land Area (1000 ha) in Europe, FAO, 2016 (Generated at http://www.fao.org/faostat/en/#data/RL/visualize)

As with measures specifically designed for the agricultural sector, measures such as 'urban drainage' that were designed for urban areas are generally only transferable to other urban areas. This limits the transferability of these measures in geographical terms. The degree of urbanization is, however, relatively high throughout Europe and is unlikely to be an important factor restricting transferability (Figure 7).

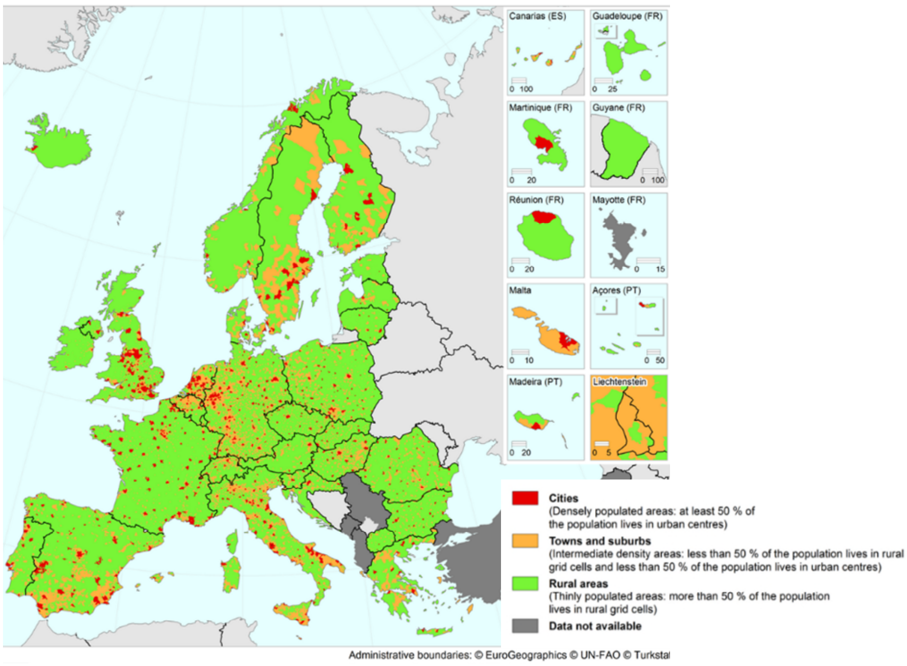

Figure 7: Map of the degree of urbanization of local administrative units in Europe, Eurostat, 2016 (Generated at https://ec.europa.eu/eurostat/web/degree-of-urbanisation/background)

In addition to the categories of measures as defined in the BINGO Portfolio, the individual measures also have particular attributes and demands on the (governance) context that influence their potential transferability. Measures that depend on one actor to be implemented are likely to be most transferable, because of the relative simplicity of the decision making process and the lack of conflicting views and/or interests in this phase. High demands on administrative resources and coordination of diverse stakeholders during the operation phase is also likely to limit the transferability of a measure. Additionally, measures that require behavioral changes (by many actors) are likely to be less easy to transfer. Table 2: contains each of the BINGO adaptation measures scored according to (1) the relative number of actors needed to implement the measure, (2) the number of actors needed to manage/maintain the measure, and (3) the need for behavioral change (by end-users) to make the measure effective. These scores are expressed on a three step ordinal scale: Less (Green/+); Average (Yellow/0); More (Red/-).

Adaptation Measure	Actors needed to implement the measure	Actors needed to manage/maintain the measure	Behavioral change necessary
Education and awareness raising among farmers	0	+	-
Individual contributions to (urban) water management	+	+	-
Individual water retention and storage	+	+	0
Public awareness campaigns on litter	0	-	-
Public information campaign on flood emergency response	0	-	-
Agricultural Water Pricing	-	0	-
Agricultural weather insurance	+	-	0
Flood insurance	+	-	0
Floodplain management (zoning)	-	-	0
Water transfer banks	-	-	0
Counteract illegal dumping and connections	+	+	-
CSO emergency response	-	-	0
CSO management plan	0	0	0
CSO quality standards	+	+	+
Develop a code of good agricultural practices	0	+	0
Early warning and emergency planning	-	-	-

Improve PWS management	0	0	0
Improve the management of local irrigation networks	-	-	0
Lifestock waste management	0	0	0
Measures to improve surface water quality	0	0	0
Private water use restrictions	+	+	-
Product regulation	+	+	0
Public water allocation	-	+	-
Restrict agricultural water abstraction	-	+	-
Street cleaning programs	+	+	+
Connect PWS distribution infrastructures	+	+	+
Counteract erosion and clean river banks to reduce debris inflow into the urban sewage system	-	-	0
CSO treatment	+	+	+
Desalination	+	+	+
Improve irrigation infrastructure	-	0	+
Install filtering mechanisms at inlets	+	+	+
Installing water-saving equipment	-	+	-
Modernize PWS infastructure (distribution, reservoirs, pipes)	+	+	+
Modernize PWS treatment plants	+	+	+
Natural water retention (SUDS)	0	0	+
Relocation of abstraction sites	0	+	+
Sewer separation	+	+	+
Structural flood protection	-	0	+
Use of drought-tolerant crops	-	-	-
Waste water reuse	-	0	-

Table 2: Categories of BINGO adaptation measures

In general, the infrastructure and technological measures, such as modernizing infrastructure and implementing sewer separation, appear to require less actors to be implemented and managed, and they also necessitate less behavioral change. Transferability for complex measures involving various actors may still be promising within a single governance context e.g. upscaling at a current BINGO research site. But the infrastructure and technological measures may have a relatively higher level of potential transferability beyond the research sites, since these measures are likely to be met with less social barriers. On the other hand, some of these measures, such as the use of drought-tolerant crops, entail changes in (behavior of) actors throughout the entire supply chain right down to the consumers (Table 2). It is implausible that actors at a potential target site would choose to prioritize a measure has little risk-reduction potential, just because it theoretically has a high level of transferability. Nonetheless, various social, political, and cultural factors influence such a decision making process and the available information provides insufficient grounds to make predictions. The risk-reduction potential of the various measures, and their relative cost effectiveness (D5.3), was assessed as part of the prioritization process in BINGO.

To move beyond the theoretical considerations it is interesting to consider which of the adaptation measures in the BINGO Portfolio were actually prioritized by stakeholders at the research sites. Table 3 below presents an overview of the adaptation measures prioritized per site. It is not possible to make a one-to-one comparison between the measures listed in the BINGO Portfolio and those prioritized at the research sites because the local researchers and stakeholders gradually augmented and tailored the generic measures in the Portfolio to suit their specific context and problem definitions.

Research site	Adaptation Measure
Wuppertal, DE	Alignment protection
	Technical protection measures for property
	Retention basin
	Substitution with alternative water sources or water saving
	Transition between reservoir catchments
	Reduction of low water elevation
The Veluwe, NL	Agricultural water restrictions
	Artificial retention
	Land use change
Tagus, PT	Waterproofing of irrigation channels
	Construction of intermediate reservoirs
	Change open channels into pressurised pipes
	Upgrade of irrigation equipment
	Install agro-meteorological monitoring system
Peristerona Watershed / Trodos Mountains region, CY	Desalinized water
	Groundwater recharge systems
	Treated sewage water for irrigation

	Irrigation scheduling technologies
Bergen, NO	Safe flood ways
	Public involvement
	Sewer separation
	Sustainable Urban Drainage Systems
Badalona,SP	Early warning system
	Increase of inlet, drainage and retention capacity
	Sustainable Urban Drainage Systems

Table 3: Adaptation measures prioritized by the six research sites.

It is interesting to note that stakeholders mostly prioritized infrastructural and technological measures. This might be considered to be significant because two thirds of the measures in the BINGO Portfolio are management interventions. The analysis of attributes of adaptation measures that influence their transferability would suggest that these technological measures face less social barriers to transfer and are most straightforward to implement with relatively less behavioral change and coordination of actors being necessary. All the same, there are various other factors that may have driven stakeholders to prioritize infrastructural and technological measures. For example, the outcomes of biophysical interventions are generally relatively direct and predictable. For instance, an increase in inlet, drainage and retention capacity results in outcomes that can be calculated in cubic meters and translated into risk reduction. Education and awareness raising, on the other hand, is likely to has indirect effects that are less predictable.

In addition to the predictability of the outcomes, there are other factors that may have driven the BINGO stakeholders to prioritize infrastructural and technological measures. For example, many of the local actors and professionals had a technical background in engineering, asset management, or water management. The majority of BINGO researchers were also specialized in technical fields. The technical measures thus have more 'grab' for these actors. Grab is one of the components of generalizability as defined in classic grounded theory: "Grab is the ability of an idea to snag the attention of a person quickly. "(Glaser, 1978, quoted in Chametzky, 2013). The training and experience of the people involved in the BINGO project may thus have introduced a bias towards technical measures. It is interesting to consider, in this light, whether the infrastructural and technological measures are also most cost-effective and whether they have the highest risk-reduction potential (D5.3).

4.2.5. Self-assessment of transferability by local researchers

To assess the transferability of the measures themselves, the local research partners needed to specify the contextual dependencies and beneficial governance conditions for the strategies that they developed for their specific sites, based on the generic concepts. The BINGO research partners confirmed that the generic/conceptual adaptation measures are highly transferable. For example, the flood risk reduction measures that were explored in the Wupper region were seen to be "basically applicable everywhere." Similarly, the concept of using treated sewage water for irrigation, which was explored in Cyprus, was considered to be transferable to most locations in southern Europe (Mediterranean) and elsewhere if tertiary treatment, good quality control and irrigation guidelines are in place. The lower price relative to the cost of fresh irrigation water as seen to be a factor that may support acceptance at new target locations. On the other hand, acceptance of treated sewage water for irrigation by farmers is not self-evident at all potential target locations.

The concept of "reduction of low water elevation", which was explored in the Wupper region, was considered to be relatively less transferable because it must be ecologically feasible to reduce the water flow downstream of the target site. Similarly, desalination for domestic water supply was considered by the research partners in Cyprus to be a potentially environmentally-damaging measure of last resort for water scarce areas. In addition, some technologies were seen to have a higher level of potential transferability in the future. For example, the irrigation scheduling technologies, which were prioritized in Cyprus, were seen to be more transferable once the cost of the technology has been reduced by technological innovations such as sensors, loggers, Internet of Things. The partners in Cyprus emphasized that participatory research is important to increase the potential transferability of this measure, for example by testing the technology in farmers' fields and transferring experiences between farmers.

In the self-assessments several researchers mentioned the management prerequisites for successful transfer. For example, groundwater recharge check dams were seen by stakeholders in Cyprus to be a highly transferable measure, that has already been implemented at various location in the Mediterranean, while the potential for further transfer is still great. The high cost-effectiveness of this measure was seen to be a main reason for potential target sites to prioritize it. At the same time, the stakeholders from Cyprus emphasized that management aspects need to be taken into consideration. For example, the division of responsibilities between local authorities and water authorities should be clear. Subsidies, such as the Rural Development Program (Common

Agricultural Policy) were seen to be an important factor that would promote the transfer of some measures, such as the new irrigation scheduling technologies.

In addition to the technical measures, the partners from Bergen found the public involvement measure that they prioritized to be transferable within the Norwegian context. The systematic use Communities of Practice and stakeholder involvement was a first-time experience for the actors in Bergen, and the knowledge and experience from this case is already being exploited in other inter-regional projects such as BEGIN. Other cities in Norway are also looking to benefit from some of the knowledge obtained in BINGO, especially concerning the safety considerations related to the measures. The research partners from the Wupper region confirmed that the potential transferability of the decision support methods and tools used in BINGO is high. There are plans to use the methods for comparison and prioritization of measures for other creeks in the Wupper area in the near future.

4.2.6. Causal mechanisms underlying adaptation measures

The mechanisms that determine the effectiveness of the adaptation measures may be actualized, or not, depending on various contextual conditions (Section 4.2.7). In addition, depending on the contextual conditions, the same adaptation measure may produce different outcomes. The aim of this analysis of the causal mechanisms underlying adaptation strategies is thus to assess what effects the adaptation measures are hypothetically *capable* of producing, rather than evaluating what they *will* produce. The BINGO project does not allow for causal mechanisms to be traced by constructing a causal chain of evidence from observations. Research sites have considered various adaptation measures, based on theoretical assessments made by researchers and end-users, but the adaptation measures have not yet been implemented and some will not be implemented. The hypothetical effectiveness of the adaptation measures has been assessed using simulations in hydrological models, producing projected risk reduction potential, and by means of socio-economic multi-criteria analysis (D5.3).

To explain how an outcome was brought about, by an adaptation measure in a particular case study (e.g., “A led to E through steps B, C, D”) we would need to work backwards from events (causes-of-effects explanations). This is not possible for the BINGO adaption measures, which have been prioritized but (mostly) not yet implemented. If we were to adopt the position of a positivist in theorizing from case studies (Table 2); an approach whereby causal relationships are isolated from the context of the case and net effects of causes are specified (effects-of-causes explanations), then we might theorize about the effects of certain adaptation measures (Welch et al., 2011). This is basically the approach taken in Work Package 5 of BINGO (D5.3), where the 'risk reduction potential' of the various measures has been calculated. But to theorize about the transferability of the measures it would be preferable to work backwards from the empirically measured effects by means of 'process tracing' to understand how the risk reduction was achieved via a causal process in a certain context (causes-of-effects explanations).

Process tracing can be performed assuming that each given measure will have a given effect; that is, that A in the context of B, C may cause Y. But in other circumstances the same measure may result in different outcomes; for example, if the outcome Y only occurs in the absence of C under certain contextual conditions. This is likely to be true for most of the BINGO adaptation measures. Welch et al (2011) expressed this type of relationship using Boolean algebra as follows Y = (A AND B AND C) OR ((NOT B) AND D AND E). In other words, to understand the effect of B it is necessary to understand the relationship between B and the spatial-temporal context. This "multiple conjunctural" view on causation was developed by Ragin (2000; Rihoux & Ragin, 2009) to explain the outcome of a measure by factoring in the combination of conditions found in a case study.

The "multiple conjunctural" approach is quite a different to that used in case studies of the type where the aim is to calculate the net effect of an 'isolated' variable or measure. To express this in relation to the BINGO, the adaptation measure 'public Involvement' (A) may work well in a context where a high percentage of citizens are interested in being involved (B) and there is a good deal of trust and confidence in public service authorities (C). At the other extreme, if there is little trust in authorities and most citizens are uninterested and uninformed then 'public Involvement' is likely to be less successful. Then again, 'public Involvement' (A) combined with a high percentage of citizens interested in being involved (B) may exacerbate problems even further if there has been a recent health scare concerning drinking water quality (D). It is thus not useful to generalize the overall effect of 'public Involvement' (A) and the relationship with the percentage of citizens interested in being involved (B) without saying something about recent health scares (D). The Boolean expression "Y = (A AND B AND C)" thus lacks the necessary complexity. This is a configurational view on causality, and one suitable to understanding the transferability of the measures prioritized in the BINGO case studies, after they have been implemented and evaluated.

According to the adopted model for assessing transferability (section 4.2.1), a clear understanding of the (assumed) causal mechanisms is required to judge whether and, if so, which adaptation strategies can be exploited beyond the research sites. Deliverable 5.3 provides detailed descriptions of these causal mechanisms as the basis for evaluating the risk-reduction capacity of each measure. Actors at potential target locations are advised to read this deliverable to understand the intended causal mechanisms and to evaluate the potential transferability to their local circumstances. Previous BINGO research has also provided information about the relationships between the objectives and the measures, as understood by the researchers and end-users at the various research sites. Each adaptation measure has been characterized according to four main aspects:

1. The BINGO objective
    a. Decrease of water quantity due to drought
    b. Decrease of water quality due to drought
    c. (Flash) Floods
    d. Decrease of water quality due to increased precipitation

2. The targeted sector
    a. Water Resource Management
    b. Public Water Supply
    c. Urban drainage
    d. Flood safety
    e. Agriculture

3. The BINGO scope
    a. Continuity of service
    b. Sustainable management of resources
    c. Protection of the environment
    d. People and property safety
    e. Economic management

4. IPCC´s categorization
    a. Structural/physical
        i. Engineered and build environment
        ii. Technological (e.g. irrigation or fertilization)

iii. Ecosystem based (using ecosystem functions to adapt)
iv. (Basic public) Services (e.g. health, water, housing)

b. Social
   i. Educational (e.g. awareness raising)
   ii. Informational (e.g. hazard-mapping)
   iii. Behavioral (e.g. changing water use or cropping practices)

c. Institutional
   i. Financial (incentives or direct funding of activities)
   ii. Laws and regulations (e.g. protected areas, technological standards, building codes)
   iii. Government policies and programs (e.g. adaptation plans)

The causal chains linking hazards (what can go wrong) to the vulnerabilities (if it does go wrong, what are the consequences) in terms of risks have been described in detail in Work Packages 2, 3 and 4 (Figure 8). These generic causal chains/pathways are seen as the 'business as usual' scenario to model what would happen if the research sites were to not implement any adaptation measures.

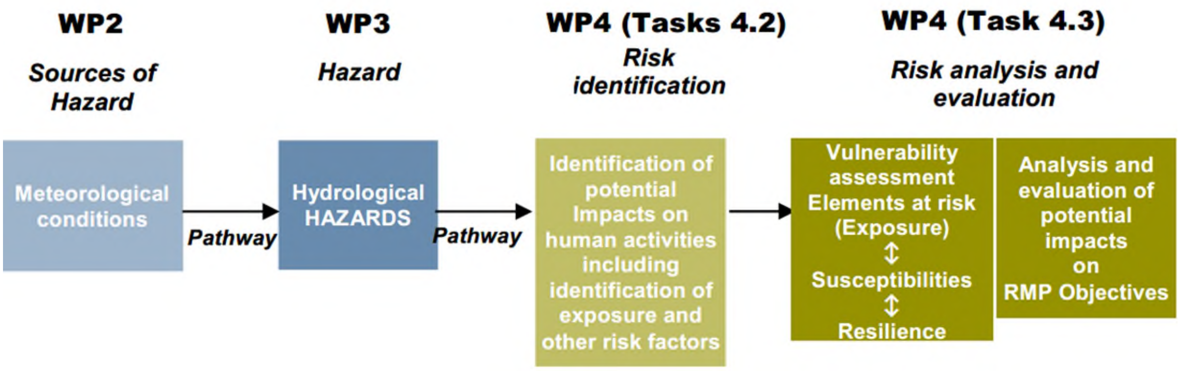

Figure 8: From hazard sources (meteorological conditions) to hazards (hydrologic repercussion). Taken from D4.2.

In addition to the causal chains that generate risks (Figure 8), the causal chains linking the adaptation measures to risk reduction have been assessed in Work Package 5 (D5.3). These causal chains/pathways are more specific and were used to model what is likely to happen if the research sites were to implement a particular adaptation measure. For assessing the transferability of the measures it is not necessary to describe the causal chains that have been defined for each measure. It is necessary to understand whether some measures have complex and indirect causal chains that are highly contingent on certain circumstances, thus limiting their transferability, relative to the simple and direct causal chains that are associated with a higher level of transferability.

In Section 4.2.4 on the attributes of measures it was established that the infrastructure and technological measures, such as modernizing infrastructure and implementing sewer separation, generally require less actors to be implemented and managed, and they also necessitate less behavioral change. Theoretically, these attributes make them more transferable. When it comes to the causal mechanisms underlying the adaptation strategies, a similar conclusion might seem logical. But for the causal mechanisms it is essential to first define what constitutes an ‘effect’. The direct and predictable effects of the infrastructure and technological measures and do not necessarily bring about the risk reduction that they were designed for. Consider, for instance, the infrastructural measure of constructing a transfer pipeline between two reservoir catchments. The direct effect of this measure is obviously that water can flow between the two reservoirs, but accomplishing actual risk reduction is contingent on more intermediary steps. And the indirect effects are less self-evident and less predictable.

Water managers may build a transfer pipeline with the aim of optimizing inter-reservoir storage. To reduce the risk of water shortages due to climate change, however, the water demand must remain at the at the same level as, or less than, that prior to implementing the measure. But water users who learn that their once limited reservoir is now linked with a second, larger source may, for example, be inspired to undertake more water intensive activities while, from the perspective of the water manager, the overall capacity is unchanged. The intended effect of the measure was obviously not increased water demand, but it is a possible outcome. There are also other indirect effects, such as changes to erosion and sedimentation patterns and changes to the freshwater ecosystem, e.g. alien species. Some of these indirect effects are unforeseen and unpredictable.

Relative to the infrastructure and technological measures, the social, informational, regulatory and financial measures may seem to be contingent on more (uncertain) intermediary steps (causal chains) for accomplishing actual risk reduction. For example, the municipality in Bergen is collecting information on their existing urban drainage system to identifying bottle-necks and problematic areas. The objective is to reduce the risk of decreased water quality due to combined sewer overflow (CSO) with increased precipitation (intensity) due to climate change. To achieve this objective the municipality is implementing a measure called ‘Public Involvement’, which involves providing a digital platform where the public can share information on the existing system and water courses using pictures and geotagging. Besides gathering the necessary information for technical planning, this measure is also meant to raise public awareness. As the BINGO partners in Bergen concluded, development of digital platform alone would not result in the objectives being reached. For example, campaigns are crucial for raising awareness and leading users to the website. Once users are stirred to visit the website and upload information, it is necessary that they provide information that is useful to the municipality. This is not self-evident. Similarly, the municipality will need to provide information to the public to inform them about the future risks caused by climate change, without producing unintended consequences such as creating public fear. Furthermore, to actually reduce the risks the municipality will need to make technical plans based on the information they have received and then implement these plans successfully. Similarly, citizens would need to change their behavior based on the information provided by the municipality for the measure to have the intended consequences.

Relative to public involvement, which is an informational measure, the causal mechanisms that link to sewer separation, which is an infrastructural measure, to the risk reduction objectives appear to be more direct, less contingent, and less uncertain. Sewer separation involves the construction of separate collection systems for municipal wastewater and surface run-off. The separate collection prevents the overflow of sewer systems and treatment stations during rainy periods and avoids the mixing of relatively clean surface run-off with chemical and microbial pollutants from the municipal wastewater. The surface water run-off/rainwater can then be used to increase the supply of groundwater through groundwater recharge. This measure has direct effects on risk reduction: it has proven to be a highly effective measure throughout Europe and worldwide. On the other hand, sewer separation is exceedingly expensive relative to public involvement. But to compare these two measures in this way is meaningless. Public involvement is also used at a different phase in the adaptation strategy, to identify the problem areas, whereas sewer separation is a measure that is directed at solving the problem. A combination of both measures is thus interesting, as the Bergen case suggests.

So while the infrastructural measures may reach the objectives via more direct causal mechanisms, making them more transferable, their proper design may depend on foregoing informational, regulatory and financial measures. Considering the infrastructural and technical measures in isolation may thus be more of a theoretical exercise, and less meaningful for the actual transfer of measures to target locations. The actual causal mechanisms, which might be traced by constructing a causal chain of evidence from observations after the measures have been implemented, are likely to differ per site. As described in adopted model of transferability (Section 4.2.1), the causal mechanisms (adaptation measures) are considered to be related to their effects (BINGO objectives) in contingent and external ways (Welch et al. 2011) that include both physical and social dimensions. Causal mechanisms may not always be empirically observable and, even if they are observable, the BINGO research was not intended to provide reliable theories about their existence, let alone their workings. But general it can be concluded that the technical and infrastructural measures are likely to be more transferable due to the relative simplicity of the causal mechanisms by which they work. All the same, there are considerable differences between causal mechanisms by which the various technical and infrastructural measures work as regards how direct, contingent, and certain they are. Sewer separation has quite direct and certain consequences, as described above, whereas a measure such as installing water-saving equipment in households is more complex and uncertain. Based on the simplicity of the causal chains the following measures are likely to be most transferable:

- Sewer separation
- Flood insurance
- Private water use restrictions
- Street cleaning programs
- Connect PWS distribution infrastructures
- Counteract erosion and clean river banks
- CSO treatment
- Desalination
- Improve irrigation infrastructure
- Install filtering mechanisms at inlets
- Modernize PWS infrastructure (distribution, reservoirs, pipes)
- Modernize PWS treatment plants
- Natural water retention (SUDS)
- Relocation of abstraction sites
- Sewer separation
- Structural flood protection
- Use of drought-tolerant crops
- Waste water reuse

4.2.7. Contextual conditions determining the effectiveness of measures

The BINGO project included ten case studies at six research sites (Table 4). It might thus seem logical to assume that there are thus six sets of contextual conditions that we must consider to determine the effectiveness of the measures. However, if we take the Bergen research site for instance, the reservoir intakes are located at a different place to the Damsgaard Area and the urban drainage problems (CSO's) involve different stakeholders to those for the drinking water reservoirs. We must thus consider each of the ten case studies as having different contextual conditions.

Country	Research site	Case study	Climate extreme
DE	1. Wuppertal	Too much water	Flood
DE		Too little water	Drought
NL	2. The Veluwe	Too little water	Drought
CY	3. Peristerona Watershed / Trodos Mountains region	Irrigation	Drought
CY		Public water supply	Drought
NO	4. Bergen	Damsgaard Area	Flood
NO		Reservoir intakes to Bergen	Drought
SP	5. Badalona	Urban drainage (CSO's)	Flood
PT	6. Tagus	Public water supply	Drought
PT		Agriculture	Drought

Table 4: overview of the ten BINGO case studies

The context within which an adaptation measure is implemented governs the effectiveness of the measure. This context constitutes a variety of factors, including the social, political, economic, ecological, and geographic circumstances. Each of the research sites has been characterized according to the Three Layer Framework for Water Governance, relative to the adaptation measures that they prioritized for exploring in BINGO (Table 3):

1. Content Layer
    a. Policy framework
    b. Knowledge requirements
        i. Technical knowledge
        ii. Administrative knowledge
        iii. Knowledge about behavior, interests and preferences
    c. Experience/skills
2. Institutional Layer

   a. Organizational requirements
      i. Responsibility structure
      ii. Administrative resources
      iii. Implementation level or scale
      iv. Implementation time
      v. Life time
   b. Legal requirements
      i. Relevant EU legislation, policy and directives
      ii. Legal-operational requirements
   c. Financial requirements
      i. Costs
      ii. Financing structure
3. Relational Layer
   a. Culture and ethics
   b. Public accountability, communication, and participation
   c. Links to other policy sectors
   d. Cooperation, Communication

As regards transferability, these characteristics provide some information about the contextual conditions that determine the effectiveness of adaptation strategies. Site specific assessments have been made for each of measures. The following Table 5 is a similarity/difference of answers to the questionnaires following the 3 layered framework. This analysis is much too rough to be used as the basis for any detailed conclusions. There is, for example, no real independent variable in this analysis, since the answers to the 3 layered framework questionnaires are relative to the specific measures chosen by the different sites and the sites prioritized different measures. Even so, if the sites had chosen 'the same' generic measures then these measures would also have been altered to comply with particular interpretations and tailored to fit the local contextual conditions, which would make them different as well. The matrix thus compares across research sites, and according to the local stakeholders, how conducive the local governance circumstances are for the measures prioritized at these sites. It is important to note that the questions about the content layer refer to knowledge and information about (future) climate change, and not knowledge about water management. Actors who have the highest level of knowledge and information about their water supply system may, for example, respond with relatively low scores as regards the availability of information and knowledge about climate change. For gaining any understanding about the current contextual conditions the qualitative analysis given in D5.4 is indispensable. The only purpose that this rough analysis serves (Table 5) is to show that the six research sites have quite dissimilar current situations as regards the self-assessment of the readiness of the governance context, according to the answers given to the 3-layered framework interviews (D5.4). All of the answers have been be reduced to a three step ordinal scale: Yes (Green/+); Partly (Yellow/0); No (Red/-).

Research site: / Layer/Question	Wuppertal	The Veluwe	Peristerona Watershed	Bergen	Badalona	Tagus
Content Layer						
Is there a clear policy and planning for water management in your region?	0	+	+	+	+	+
Is there sufficient and relevant information available?	-	0	0	+	0	0
Are the necessary knowledge and skills available?	-	0	0	0	0	-
Institutional layer						
Are the roles and responsibilities clear?	0	+	0	+	+	-
Are the necessary tools available?	+	0	0	0	-	-
Is functioning of the financing system ensured?	+	0	-	+	0	+
Relational Layer						
Is the water policy well connected with other policy fields (e.g. spatial planning)?	+	0	0	+	-	0
Are all stakeholders involved in decision making for water management?	0	+	0	0	-	0
Is there transparency in water management?	+	+	0	+	-	0
Is there enough confidence to work together?	+	+	+	0	0	0
Are actors comfortable working together?	+	+	0	0	-	0

Table 5: Similarity/difference matrix of answers to questionnaires following the 3 layered framework. The six research sites obviously have quite different current situations as regards the contextual conditions

Based on this rough analysis, and reading the qualitative reports, we argue that it is safe to assume that the six research sites currently have quite dissimilar contextual governance conditions. This analysis also suggests that The Veluwe and Bergen were most (similarly) prepared for the adaptation measures that they prioritized. This might indicate that these research sites have the most similar governance contexts, but the results are inconclusive. Wang et al. (2005) state that "it is inherently a matter of judgement as to how much resemblance there is between the original study context and the local context." It can be concluded that the BINGO partners at the Veluwe and Bergen sites both consider their local governance circumstances to be conducive to the measures they prioritized. Stakeholders in Badalona, on the other hand, consider their governance context to be as yet relatively less conducive to successful implementation of the prioritized adaptation measures.

The relationship between the contextual conditions and the adaptations measures is discussed in the previous section on causal mechanisms (section 4.2.6). It is, however, interesting to consider the transferability of (1) the BINGO approach, and (2) the decision support methods and tools in relation to these contextual conditions. The fact that the BINGO approach resulted in prioritization of measures in such dissimilar conditions is reason to suggest that it is a transferable approach that is likely to also work with diverse measures at diverse locations. This is also true for the decision support methods and tools that were applied at the various research sites.

4.2.8. Transferring The BINGO approach and tools

The BINGO approach, including the application of decision support methods and tools and the use of Communities of Practice (CoPs) has been described in various deliverables, including D6.5, D6.6 and D6.7 and D5.3. Examples of methods include the Risk Management Approach, Water Cycle Safety Planning and more generic methods such as cost-benefit analysis, road-mapping, and multi criteria analysis (MCDA) in combination with cost-effectiveness analysis. A precondition for transfer of the decision support methods for prioritizing adaptation measures is that the target site has defined a discrete and feasible set of potential adaptation measures beforehand. The BINGO Portfolio provides a good starting point for satisfying this requirement. For example, BINGO partners at the Wuppertal research site indicated that the methodology for flood risk reduction, and especially the comparison and prioritization of measures, is likely to be transferred to other creeks in the Wupper area in the near future. In addition to the more generic and transferable models and tools, BINGO also resulted in improved (groundwater) models and downscaled (locally relevant) climate ensembles for the specific research sites. These particular tools and methods, which were specifically tailored for a distinct research site are considered to have limited transferability.

For stakeholders and water managers at new target sites to start working with Communities of Practice (CoPs), it would be helpful if they could observe a CoP in action. At the outset of the BINGO project, representatives from each of the six research sites participated in a workshop where the concept of a CoP was described and demonstrated. During the project there were also meetings between those responsible for the CoPs at the different sites to share perspectives and plan the BINGO-specific combination of the CoP approach with road-mapping methods. The BINGO project has produced guidelines for creating, feeding and enhancing "win-win" collaborations between researchers and stakeholders, based on experiences and reflections in these CoPs. D6.5 details the learning outcomes and experiences from the CoPs at the 6 research sites. These guidelines, as with the others presented on the BINGO website, are meant to facilitate the transfer of these methods to new locations beyond the research sites. They include instructions, recommendations and advice, based on lessons learned, so that the people who are looking to transfer the approach can avoid making mistakes that the BINGO partners learnt from.

If we consider the ten case studies at the six BINGO research sites to be 'contextualized explanations' of how adaptation measures can be prioritized using a specific set of methods and tools, then it would be important to understand how each decision support tool contributed to the decision making. The BINGO researchers recorded these insights in the form of guidelines, but these are more generic and less descriptive than, for example, what would be necessary for a discourse analyses of the minutes of the meetings. The reports recording the (outcomes of) workshops at the six research sites do provide some insight on this level (D5.2). The focus, however, was on postulating about the causal mechanisms by which each adaptation measure would work, as the basis for projecting theoretical, modelled risk reduction effectiveness per measure within the local contexts. When referring to the transferability of the tools and methods it is thus important to distinguish transfer of the method/tool itself from transfer of the understanding about how the tools were used at the various BINGO research sites.

Encapsulated in the (design of) methods and tools is knowledge that is not necessarily communicated explicitly with the potential users. For example, a particular method for involving stakeholders in decision making may have been designed based on theories that are scientifically grounded in (group) psychology. It is not, however, necessary for the end-user to first understand these psychological theories before they can apply the method. It is thus possible to transfer useful approaches and tools without transferring the underlying information and knowledge. A software model, for example, could be downloaded and applied by people beyond the research sites without the knowledge that was needed to build the model. This makes these tools and methods more transferable than the knowledge that was needed to design them. At the same time, the underlying knowledge and the data and information that was used or produced in the BINGO approach is also valuable and (partially) transferable.

4.2.9. *Transferring data, information, and knowledge*

Data and information can be stored and shared, both digitally in (online) databases and documents and in hard-copies. To make data useful for decision making, and translate it into information, an extra processing step is necessary to organize and analyze it and present it in a way that makes it relevant to the questions at hand. Within the geographical extent of the simulation domains (see Figure 9) the (downscaled) climate data is directly useful to people beyond the six BINGO research sites. People at locations beyond the geographical extent of the simulation domains will need to use the downscaling methods developed/used in BINGO to generate their own locally relevant data. There are various reports (e.g. D2.4 and D2.5) that describe how present and decadal prediction climate extremal episodes were downscaled. The BINGO project also produced tools, such as the precipitation guided conditional stochastic weather generator (D2.8), that is also useful to people beyond the six BINGO research sites.

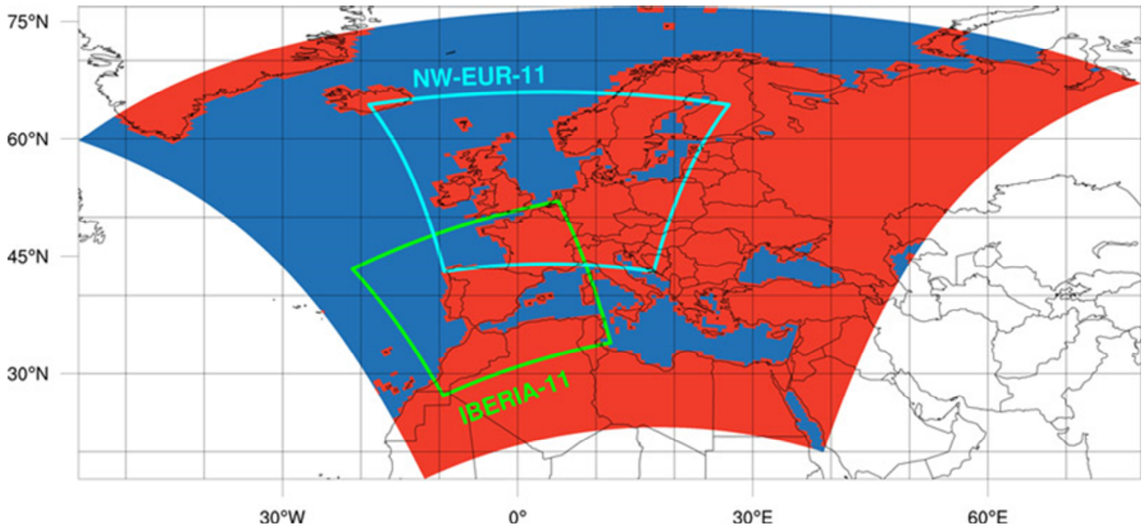

Figure 9: Simulation domains. The ERA-Interim-driven present climate simulations cover the EURO-CORDEX domain, shown as the blue/red shaded region. The decadal predictions are downscaled over two smaller sub-domains covering Iberia (for the Tagus and Badalona research sites) and north-western Europe (for the research sites at Wupper, Veluwe and Bergen).

The data that was provided to BINGO project partners made use of the DECO (Data Extraction and COnversion) plugin, as part of the Freie Universitaet Berlin's (FUB) FreVa system. This DECO plugin is a tool which processes the regional climate model output into a customized format based on the individual requirements of the hydrological modelers at particular target site, including the option of correcting bias in the climate data. The DECO plugin thus increases the transferability for the data by making it useful to a broader target group. The DECO plugin, and how to use it, has been extensively documented by the FUB (https://freva.met.fu-berlin.de/).

The information produced in BINGO is recorded in (online) text documents, diagrams, maps, and videos available at the download area of the BINGO website (http://www.projectbingo.eu/resources). Information is the most standard outcome of a project such as BINGO, and the main purpose of this information is to transfer it to people beyond the research sites by communicating it in reports and online. The most important information, in the form of milestones, deliverables, and other (scientific) publications, as well as policy briefs, can simply be transferred by sharing and downloading the relevant documents. People at the target locations beyond the research sites may be interested in background information and more thick descriptions about how the BINGO project actually worked. The D5.2 report, which summarizes the outcomes of the first two series workshops, is an example of information of this type. Other reports, such as D5.1, provide guidance to readers beyond the research sites and explain how to use certain tools. To increase the transfer of this information, it is important that it remains online beyond the lifetime of the project. Additionally, the names and contact details of the people who prepared the information are included in the deliverables so that new end-users at target locations can request more explanation where necessary.

The BINGO exploitation plan (WP5) has been carefully prepared to maximize the transfer of information generated in BINGO. Figure 10 shows how the information is intended to be shared with clearly defined end-users via fitting communication channels and specified actions. The online portfolio of adaptation measures is perhaps the BINGO outcome that is most obviously intended to promote transfer, but all of the actions and channels listed in Figure 10 have been employed to provide potential end-users with information generated in the BINGO project.

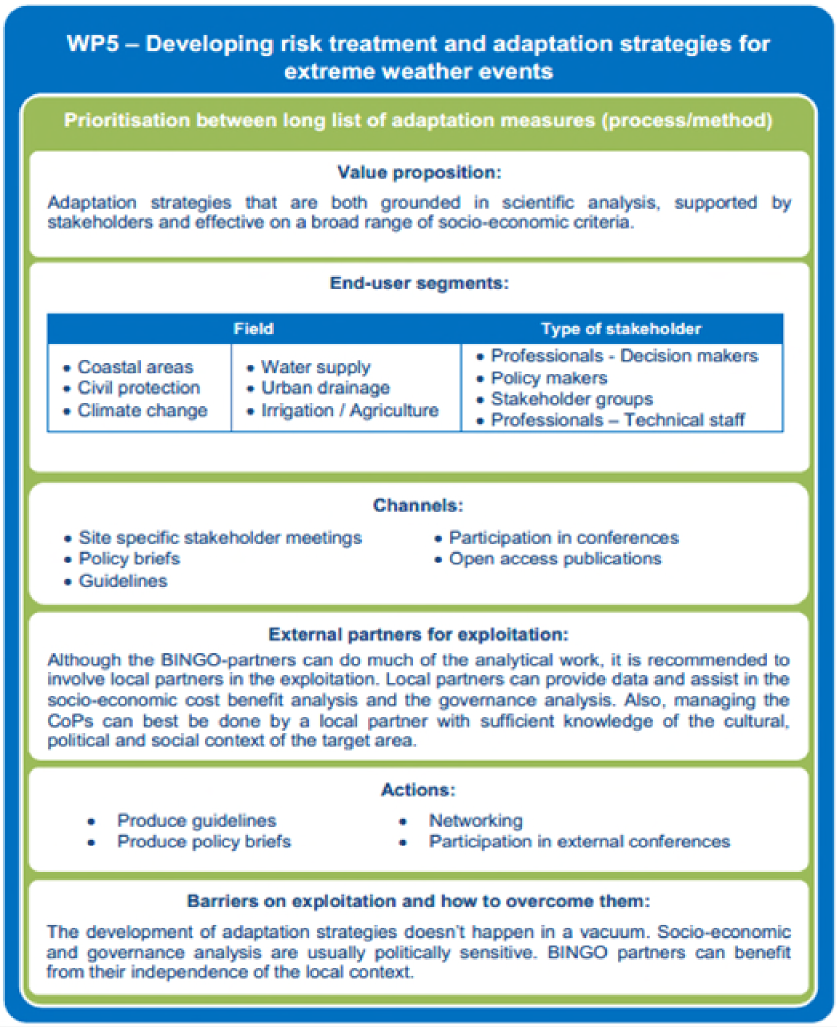

Figure 10: Link to the bingo exploitation plan

The internalization of the external information into subjective knowledge, by learning and comprehending, is a less simple process than information transfer. The exploitation plan deals with this type of transfer with channels such as participation in conferences and site specific stakeholder meetings. Knowledge is that which is known; that is, in the mind of the knower(s). From the perspective of the BINGO partners, knowledge transfer depends on the potential and the ability to convert the knowledge into information that exists outside of the mind and can be shared with others beyond the research sites. The explicit knowledge that is transferable must first be codified in language/ information to be communicated. In European projects it has become common to speak in terms of 'dissemination of knowledge'. This term evokes images of the 'seeds of knowledge' being cast in broad sweeping motions, scattering them widely over both fertile virgin soils, where they will flourish, and hard stony ground, where they will perish (Figure 11). This approach to transfer has more in common with the ‘spontaneous diffusion’ described by Van Winden (2016), than careful and well-prepared replication. Even so, Horizon 2020 is strongly directed at improving the uptake of solutions.

Figure 11: Le semeur, Jean-François Millet, 1850

For the BINGO project we would like to consider more carefully considered and systematically designed transfer of knowledge. As with dissemination, however, it is unlikely that the BINGO partners will have intensive, direct contact with the receivers. There has been no means provided, besides the website, for facilitating dialogue with future users of the BINGO data, information, and knowledge. This limitation is inherent to projects, with a start and an finish, and not a specific limitation of BINGO. Maintaining the BINGO website and Portfolio of Adaptation Measures beyond the lifetime of the project is a worthwhile activity, which may not be trivial to organize.

It is uncommon for research projects to ‘prepare’ or ‘prime’ potential target audiences for the uptake of the data, information and knowledge that is generated, while this is a crucial step in sowing actual seeds: picking the right time of the year, weeding, tilling the area to loosen the soil, spreading fertilizer, moistening the soil, and so forth. To increase the transferability of the BINGO outcomes, it would be helpful if national governments, at least in the countries where BINGO research site were located, were to bring the BINGO project to the attention of regional water authorities and other relevant actors when communicating the water related risks associated with climate change.

4.2.10. Transfer from the perspective of target locations

Many qualitative researchers agree that the reader must assess the transferability and initiate the transfer (Moon et al., 2016; Graneheim and Lundman, 2004). This requires a detailed, 'thick' description of the context and culture, data collection and analysis, which has been the case in the BINGO project. The guidelines for tools and methods and the portfolio of adaptation options are also very useful from the perspective of actors at potential target locations. But BINGO also produced valuable outcomes that may not have to rely on end-user/reader generalizability to promote their transfer. It would be possible to complete a study to identify regions or cities beyond the BINGO research sites that are likely to experience similar problems and risks as those identified at these six sites. The definitions of extreme weather events, i.e. droughts, floods, and combined sewer overflows, could be used to produce maps showing which regions of Europe are at highest risk of these three problems. On the other hand, to judge the degree of similarity between sites would require an in-depth analysis and there is a great deal of diversity. More importantly, transfer of the measures, methods, and knowledge developed in BINGO is not likely to be limited by a lack of locations beyond the research sites where similar climate related risks will arise (section 4.2.7). These risks are so important precisely because they are so widespread.

Rather on focusing on identifying target locations that are likely to experience similar climate related risks, it would be possible to identify regions that share similar contextual conditions to those of the six BINGO research sites. As discussed in section 4.2.1 and 4.2.7, however, no two sites are likely to be similar enough to make possible the 'cut-and-paste' transfer of certain knowledge or solutions. The measures discussed in BINGO, for example, are of a conceptual nature (and can thus be transferred) but once transferred they need to be specified and tailored to the local context. The six BINGO research sites also differed greatly from each other. Within the BINGO project, the Bergen and Badalona case studies stand out in this regard. These sites share similar geographic conditions, where combined sewer overflow (CSO) occurs during intense rainfall events causing (swimming) water quality issues downstream. Both cities are located on hillsides where soil sealing, the covering of the soil surface with impervious materials due to urban development, is a problem. Stakeholders at both locations also prioritized Sustainable Urban Drainage Systems (SUDS) for consideration in BINGO.

However SUDS can take many forms, both above and below ground. Some examples include: green roofs, pervious pavements, bio-retention systems, swales, wetlands, soakaways, infiltration basins, etc. The generic concept of a SUDS was customized to match the local conditions, which resulted in quite dissimilar concrete measures in Bergen and Badalona.

From the perspective of actors at target locations, the BINGO case studies could be used for deductive purposes, to check theories about what are assumed to be promising adaptation strategies, and for inductive purposes, by using the empirical results from the BINGO research sites to form new theories about which measures are likely to work and under which conditions. The potential for inductive reasoning (drawing broad conclusions from particular instances) is considered to be limited due to several reasons, and primarily the fact that the effectiveness of the measures has only been modelled in terms of risk reduction potential, meaning there has not (yet) been an empirically grounded assessment. A longitudinal study, with review of the effectiveness of the measures at each of the research sites for at least 5-10 years, would provide a more reliable basis for inductive reasoning. Since the potential for generalizing based on case studies is considered to be constrained by contextual diversity, greater investments in extra case studies would not yield more reliable conclusions as regards transferability, except via the improved explanatory rigor of the causal mechanisms and a richer understanding of the contextual determinants. A longitudinal study would thus have the most added value from the perspective of actors at target locations.

5. CONCLUSIONS AND RECOMMENDATIONS

The main question to be answered in this deliverable was:

Which adaptation measures, knowledge, information, data and/or tools generated in the BINGO project are potentially transferable beyond the six BINGO research sites?

A succinct answer to this question is that (1) some of each type of BINGO outcome is theoretically transferrable, and that (2) the decision support methods and tools that were used to prioritize adaptation measures are both highly transferrable and particularly useful for potential target locations beyond the BINGO research sites.

The analysis that is reported on in this deliverable involved specifying which BINGO outcomes could be transferred, and what transfer would involve for each type of outcome. The conclusions are summarized in the following Table 6:

Element of adaptation strategies	Transferability beyond the research sites	How to transfer
The BINGO approach	Highly transferable, as evidenced by the BINGO project, where this standardized approach resulted in prioritization of adaptation measures at six diverse research sites throughout Europe.	*Formal:* BINGO researchers have described the steps taken (guidelines). National governments could be encouraged to support application of these methods at new locations. *Informal:* word of mouth endorsement from stakeholders and decision makers.
The adaptation measures	The generic concepts themselves are highly transferable. Once modified and specified as part of the adaptation strategy for a particular research site the transferability is less (interesting).	The online 'Portfolio of Adaptation Measures' has been designed for this purpose. Transfer would be supported by making this portfolio readily available. End-users can enact the transfer themselves.
Decision support methods and tools	The specific combination of methods and tools that was applied and tested in BINGO proved to be effective at six diverse research sites. These methods are thus considered transferable.	The various decision support methods and tools are described in the guideline deliverables and combined in the BINGO approach. National governments could be encouraged to support application of these methods at new locations.
Data, information, and knowledge	The site-specific data and information is theoretically transferable, but not particularly useful beyond the research sites. The knowledge and experiences of BINGO researchers, stakeholders and decision makers is (partly) transferable and valuable.	The knowledge and experiences of BINGO researchers, stakeholders and decision makers is could be transferred to new actors and locations via conferences and workshops with people at potential target locations. End-users can access the data and information on the project website.

Table 6: Conclusions about transferability of BINGO outcomes

The transferability of the adaptation measures themselves is influenced both by attributes of the measures and contextual conditions. The 44 adaptation measures included in the 'BINGO Portfolio of Adaptation Measures' have 'conceptual generality', because they are formulated as abstract concepts. This makes them highly transferable. Modification of these measures in the BINGO project, though specification and particularization for the site-specific conditions, resulted in better fitting, less transferable products. None of these site specific strategies are demonstrably transferable, because they have not been implemented yet, let alone evaluated. The BINGO project may improve the transferability of the generic adaptation measures included the online portfolio beyond the research sites by raising awareness about them and priming actors at potential target sites to take some lesser known concepts into consideration. This portfolio of measures, along with the stakeholder involvement in communities of practice, is central to the BINGO approach.

At the outset of preparing this deliverable the focus was on comparing the various adaptation measures as regards their transferability. It was also expected to be interesting whether or not, in hindsight, the actors at the six BINGO research sites prioritized the most transferrable measures from the portfolio. But after having done more desk-research to understand the theoretical perspectives on transferability, it became evident that the decision support methods and tools that were used in the BINGO approach are the most useful and transferable outcome for people designing adaptation strategies beyond the research sites.

The claim that the BINGO decision support methods and tools are transferable rests on the fact that they were successfully applied at six diverse locations. These decision support methods also provided evidence that worked to help stakeholders break out of some assumed/entrenched positions. For example, stakeholders in Cyprus considered maintenance of check dams an expensive measure, but the assessments in BINGO indicated that this would be one of the most cost-effective measures for achieving risk reduction. The BINGO approach was implemented with help of communities of practice and a digital platform, which facilitated exchange of information and knowledge and provided structure to the decision making process. Integrating the decision support tools in a clear process, the BINGO approach was applied systematically at six research sites that were far removed from each other, in different countries with diverse challenges and various capacities and limitations for finding solutions. The fact that this approach resulted in science-based and broadly supported prioritization of adaption measures at each of the locations suggests that it is highly transferrable. National governments could be encouraged to support application of this approach, and the decision support methods, at new locations.

As regards the question of “failures” that others can learn from, so as not to make the same mistake twice (a question related to transferability), it may be concluded that the time necessary for preparing datasets and for (climate) modelling was sometimes underestimated in the BINGO project. Interoperability across models and data sharing and data quality are essential and time consuming prerequisites for scientifically informed decision making about climate change. In addition to the measures, methods and approaches, the BINGO project also resulted in data, information, and knowledge. These outcomes are highly transferable, and the BINGO partners have made great efforts to maximize this potential by implementing an exploitation plan that targets specific audiences via particular communication channels with reports, policy briefs, scientific publications, videos etc.

From the perspective of actors at potential target locations, prioritizing, designing and planning adaption measures can be seen as a ‘bricolage’ – a matter of “borrowing and copying bits and pieces of ideas from elsewhere, drawing upon and amending locally tried and tested approaches, cannibalizing theories, research, trends, and fashions and not infrequently flailing around for anything at all that looks as if it might work.” (Ball, 1998, p.126, quoted in Krizek et al., 2009). It is not our aim to transfer to other locations the adaptation measures that have been particularized for the BINGO research sites, but rather to provide information, tools, and methods that will support others throughout Europe in their own design processes. As did Wang et al. (2005) we decided to make explicit and transparent the factors underlying the judgement of transferability, so that local decision makers can form their own opinions. The BINGO case studies can thus be instructive and inspiring, without conforming to the processes of empirical research that would be necessary to make (statistically valid) reliable claims about the outcomes of the measures. As Flyvbjerg (2006) states: “formal generalization is overvalued as a source of scientific development, whereas ‘the force of example’ is underestimated.” May the BINGO project be an example for future initiatives.

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