Title

Explaining the adaptation gap through consistency in adaptation planning

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Abstract

An adaptation gap exists when adaptation efforts fail to meet adaptation needs. While conceptualizing and operationalizing this gap is challenging, we argue that it should begin with aligning climate risks with policy goals, measures, and monitoring and evaluation, what we refer to as 'consistency' within adaptation policy. Through a comprehensive European study, we demonstrate how assessing consistency in adaptation plans can enhance understanding and help reduce the adaptation gap'.

Main text

Europe is warming twice as fast as other continents[1], posing substantial social and environmental risks[2], particularly for cities where about 75% of European people live[3]. European cities face an adaptation gap, despite planning for adaptation for decades[4] and both institutional and financial support. According to UNEP[5:VI], an adaptation gap is "the difference between actually implemented adaptation and a societally set goal, determined largely by preferences related to tolerated climate change impacts and reflecting resource limitations and competing priorities". Conceptualizing and operationalizing this gap remains challenging, mainly because of difficulties in defining adaptation and measuring its baselines, progress, and goals[6]. Moreover, what is socially acceptable depends on the context and may change with socio-ecological, technological, and political conditions in the future[5,7].

Few empirical studies have assessed the adaptation gap using a clear methodological approach and set of defined proxies. Specifically in urban contexts, studies on single[8] and large-scale U.S. American cities[9] have quantified the adaptation gap using climate models and government reports to juxtapose estimated adaptation needs and adaptation progress. These studies rely on the idea that the main gap in adaptation exists between potential adaptation options in planning documents and the actual implementation of adaptation actions on the ground[8,10]. One of the most elaborate studies to date involved structured expert judgment to evaluate possible dimensions where adaptation gaps manifest, such as potential and actual levels of risk knowledge, planning, action, capacities, evidence on risk reduction, and long-term strategic pathways. The study was applied across 61 local case studies globally[11] and represents a breakthrough

in the field of adaptation tracking. However, challenges remain in defining societally accepted goals and impact levels. Moreover, existing research falls short of elucidating strategies for effectively reducing the adaptation (implementation) gap.

In this study, we contribute to these discussions focusing on the “internal adaptation policy consistency” question. Based on a European large-scale study on local adaptation planning and its progress[12], we demonstrate how a series of consistency checks applied to adaptation plans could theoretically and methodologically advance the evaluation of the adaptation (implementation) gap and, most importantly, help reduce it.

‘Consistency’ refers to the utilization of a consistent and operational conceptualization of adaptation’[13:847], which is needed to ensure that any documented difference in adaptation over time and space[14] is not a function of definitional inconsistency. ’Internal consistency’[15] refers to the same level of rigorousness in defining adaptation but within the adaptation plans themselves. We argue that the origins of an adaptation gap go back to the adaptation planning process, identifiable through specific indicators in adaptation documentation.

Plan quality studies often serve as indicators of adaptation progress[12,16–18], utilizing the adaptation management cycle as a theoretical foundation. We contend that only through rigorous[19], credible[17] and frequently updated planning routines genuine adaptation progress can be assessed. This is because shifting baselines, targets, and concurrent societal processes complicate comparisons across different environmental states[6,20]. Moreover, we argue that the adaptation management cycle has so far been framed too narrowly: as sequential stages rather than a series of interconnected decisions essential for addressing climate vulnerabilities and enhancing local adaptive capacities (see Supplementary Results 1 for details of how adaptation plans address items along the management cycle). There is substantial theory and evidence showing that linking goals and actions is crucial in policymaking[21,22]. While ‘coherency’ is typically discussed regarding alignment among policy domains, governmental levels, or organizations[23–25], there appears to be a significant gap in the analytical understanding of internal consistency within the adaptation planning domain.

We argue that alignment of adaptation planning phases is crucial to successfully plan for and achieve adaptation outcomes[12], as inconsistencies may lead to an adaptation gap. Previous research has highlighted misalignments between adaptation objectives and actions[26]. However, other inconsistencies

can also indicate an adaptation gap. We identify five key forms of consistency[12]: consistency between risks of hazards and adaptation goals (C1), between sectoral risks and adaptation measures (C2), between risks for vulnerable groups and related measures (C3), between measures for vulnerable groups and related monitoring and evaluation (M&E) (C4), and between risks for vulnerable groups and participation (C5). We use data from a sample of 167 European cities that allow for the analysis of C1 to 5, reported below (Fig. 1).

[Please place Fig. 1 approximately here]

Across C1 to C5 (Fig. 1, bottom left), European cities show the highest consistency in C2 with 52% of plans fully aligning sectoral risks with adaptation measures. The lowest consistency is observed in C5, where only 1% of plans effectively involve vulnerable groups in plan development. This translates into an adaptation gap of 70%, indicating that more than two-thirds of plans are misaligned, with significant discrepancies, particularly in planning for social climate vulnerabilities.

Looking at individual items within C1 to C5, cities exhibit the highest consistency in C2, aligning environmental risks with respective adaptation measures such as improving urban greenery and biodiversity (83% of plans for this item; respective brown bar in Fig. 1) and aligning risks in the water sector with respective actions (80% of plans). Conversely, cities falter in social vulnerability-related items, such as planning for gender- and ethnicity-related risks (rosé bars of C3 in Fig. 1; between 41% and 100% inconsistency), and in including vulnerable groups such as the elderly, children, low-income and ethnic communities in plan development (rosé bars of C5 in Fig. 1; between 92% and 100% inconsistency). Moreover, cities see challenges of including these groups in monitoring and evaluation (M&E) of measures (rosé bars of C4 in Fig. 1; between 81% and 100% inconsistency, respectively), highlighting significant gaps in inclusivity and targeted actions.

The analysis also reveals that many adaptation goals and measures lack preceding risk assessments, (the grey part of bars visible in C1, C2), particularly in sector-specific planning where 49% of decisions are made without risk consideration, compared to 52% that are risk-assessed. Notably, in the environment domain, 92% of plans fail to consider environmental risks before planning measures. This not only illustrates the interdependencies between sectors and urban functions—where the effects of measures may impact different sectors—but also risks leading to maladaptation[27,28], sunk costs, or ineffective adaptation efforts. This widespread discrepancy underscores the need for more rigorous and integrated risk assessment processes in adaptation planning.

Spatial variations of consistency forms unearth regional disparities of a potential adaptation gap across European cities (Fig. 2). Northern European and UK cities show low scores of C1, suggesting high potential adaptation gaps due to misalignments between risk of hazards and adaptation goals. Conversely, Eastern European cities exhibit lower scores in C3, C4, and C5, which focus on the sensitivities of vulnerable groups, including their risks and impacts, focused measures, monitoring, and participation. Interestingly, Eastern European adaptation plans are more recent, typically post-2018, whereas those in the UK and Northern Europe are older. This suggests that newer plans increasingly neglect the needs of vulnerable groups, revealing that merging different consistency metrics can mask significant regional differences (Fig. 2, bottom left panel).

[Please place Fig. 2 approximately here]

We acknowledge uncertainties due to the varying thoroughness in documenting the adaptation process, such as risk assessment and participation processes, and in executing outlined measures and actions, monitoring and evaluation. Moreover, we assume that an identified risk indicates a societal goal to reduce it, though the preferred extent of reduction remains unspecified. Future research would benefit from utilizing high-quality adaptation plans with more explicit goals, allowing for a more precise assessment of the quantitative adaptation gap. However, conceptual challenges persist with cascading and complex risks where measures in one sector impact other sectors. These situations often require quantitative modeling of impact networks. The strength of our methodology, however, lies in the application and quantification of readily accessible, qualitative data.

Our analysis reveals that 70% of adaptation plans in European cities exhibit inconsistencies, minimizing the adaptation potential of those plans and explaining the current adaptation gap. A significant portion of these discrepancies arises from insufficient consideration of social vulnerability, specifically in planning to implement measures for vulnerable groups, and their involvement in plan development and evaluation processes. This oversight raises equity and justice concerns. Many cities across Europe[12] and the US[29] continue to struggle with planning for just urban transitions. Our study provides a practical reference point and guidance for addressing these issues. We strongly recommend that decision-makers focus on enhancing internal consistency in future adaptation plans to narrow the existing adaptation gap.

Methods

We follow a qualitative research approach relying on data from Reckien et al. (2022)[30]. They employed policy/ planning document analysis that allows for interrogation of consistency within planning documents.

The city sample

Reckien et al. (2022)[30] covered a representative sample of 327 cities in the former 28 Member States of the European Union (EU-27 plus the United Kingdom) (EU, 2011). For an elaborate description of the data see Reckien et al. (2023)[12]. The selected cities are part of the Urban Audit (UA), a Europe-wide initiative for statistical monitoring of major European cities since 2003. The UA cities were selected by the European Commission, Eurostat and the national statistical offices based on the following criteria: (i) approximately 20% of the population is covered in each country; (ii) national capitals and, where possible, regional capitals are included; (iii) large (more than 250,000 people) and medium-sized urban areas (roughly 50,000 and maximum 250,000 population) are to be included; and (iv) urban areas should be geographically dispersed within countries. The UA cities are therefore a balanced and regionally representative sample of cities in Europe. We analyze all UA core cities of the former 28 European countries. Authors have worked in and are familiar with the language and respective urban and climate policies.

The sample of planning document

The policy/ planning documents used by Reckien et al. (2023)[12] are classified as dedicated local climate plans, addressing climate issues as their central topic, as single adaptation plans or joint adaptation-mitigation plans, or broader resilience and sustainability plans[31]. They were identified through web search in search engines (Google) and on municipal websites. The plans cover an entire local community/ municipality (not only for parts of the community) and take a comprehensive approach to adaptation/ resilience/ sustainability by focusing on more than just one or two topics or adaptation sectors (that is, we exclude sector-based adaptation plans). Their coding is based on all related and relevant documentation regarding adaptation available, e.g. the adaptation strategy, an action plan, an implementation plan, and/or a monitoring plan even though only the strategy or the action plan might be formally adopted by the local council/ municipality. If multiple subsequent plans were available, the authors analyzed the last updated plan(s). The cut-off date for including adaptation plans/ policies was December 2020 (exact dates visible in the published dataset).

The coding structure

Reckien et al. (2023)[12] coded the adaptation plans in line with the idealized adaptation planning and implementation process[18,32] according to the topics of

1. Fact base: impacts, risks, vulnerabilities
2. Goals of adaptation
3. Adaptation measures/ policies/ actions
4. Implementation tools, processes, timing
5. Monitoring & Evaluation
6. Participation in plan development and

general information of the plans and their governance context, e.g., the year of adoption, publication, or approval of the plan; the availability of a national adaptation framework/policy; and the availability of previous plans. After pilot testing, reliability and validity checks, Reckien et al. (2023)[12] employed content analysis[33,34] and coding. After coding, the data underwent cleaning and interrater reliability checks.

In line with Reckien et al., 2023[12], we call the aspects in the list 'adaptation plan quality principles I) to VI)'. For each of those principles, the author team developed a detailed coding matrix. A detailed overview of the plan topics considered and the possible response options can be found in Supplementary Table 1.

The analysis of the adaptation progress of European cities included a conceptualization and calculation of internal adaptation policy consistency, as follows: The information on local adaptation plans was coded by a research analyst familiar with the national and local climate change adaptation policy. Codes relate to the response options provided in the questionnaire, as given in Supplementary Table 1. Each response option was coded by 1 or 0. Subsequently, responses to certain plan quality principles and related questions were compared.

Here, we argue that the five forms of internal adaptation policy consistency are a perfect indicator for calculating a potential adaptation gap: that means, if adaptation goals are not set according to outlined risks, and if outlined adaptation measures are not informed by sectoral and social vulnerabilities, and if M&E is not targeted towards measures focused on groups most affected, and if participation is not organized along people most in need/ affected by climate change and adaptation, we assume the adaptation process and hence its implementation will widen the adaptation gap. Along those lines, respective questions and their matching response options can be checked for consistency between risks of hazards and adaptation goals (consistency 1—C1), between sectoral risks and adaptation measures (consistency 2—C2), between risks for vulnerable groups and related measures (consistency 3—C3), between measures for vulnerable groups and related monitoring and evaluation (M&E) (consistency 4—

C4), and between risks for vulnerable groups and participation (consistency 5—C5). For C1, we compare responses of I.3 with II.1 (see Supplementary Table 1); for C2, we compare responses of I.5 to II.1-II.12; for C3, we compare responses of I.4. with III.13; for C4, we compare responses of III.13 with V.6; for C5 we compare responses of I.4 with VI.2—as outlined in Supplementary Table 1.

Data analysis

The potential adaptation gap was identified by separately revealing inconsistencies from C1 to C5. After thoroughly revising each plan, a binary codification was applied to distinguish the addressed or missing aspects of each principle. “1” values refer to addressed aspects, such as CC impacts, vulnerable sectors, and populations; in addition, the inclusion of vulnerable social groups in M&E and participation phases. “0” values indicate that specific aspects within the form of consistency mentioned are not considered.

For quantitative purposes, we applied pairwise analysis by devising multiple IF functions to distinguish inconsistent and consistent aspects within each principle.

Furthermore, we identified a specific case where the second aspect is present without the previous planning step (i.e., addressed actions related to a previously undefined risk). The theoretical maximum value of potential adaptation gaps was 6, 12, 10, 10, and 10 from C1 to C5, respectively.

We did not compare goals and measures, but risks (hazards for vulnerable groups) and measures. This is because goals are usually so generally formulated[12,26] and so shortly outlined that they hinder a useful comparison to adaptation measures. The risk level was used as a substitute for goals, assuming that an identified risk indicates a societal goal to reduce it, but not how much of a reduction would be societally preferred or tolerated. The question of tolerated impacts, preferences, resource limitations, and abilities remains untouched.

Data availability statement

The open-access datasets that support the findings of this study are available at https://doi.org/10.17026/dans-xd6-w7pc.[30]

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Author Contribution Statement

D.R., A.B. and M.O. conceptualized the study. D.R. and A.B. conducted the statistical analyses. D.R., A.B., P.F., and M.S. developed the figures. All authors contributed to writing and editing.

Competing Interests Statement

The authors declare no competing interests.

Figure Legends/Captions (for main text figures)

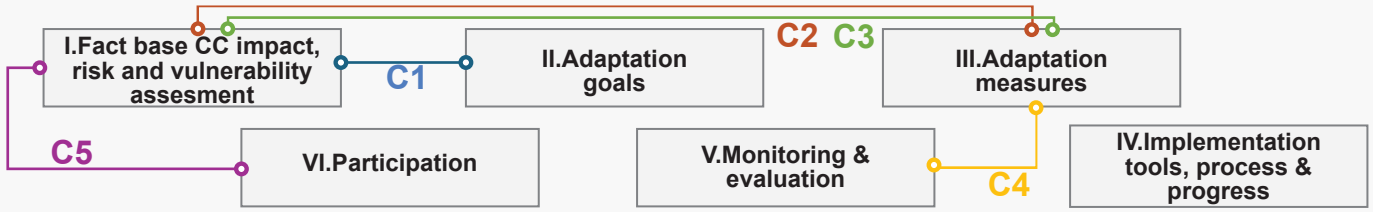
Fig. 1: Conceptualization and empirical demonstration of the potential adaptation gap. The conceptualization of the potential adaptation gap is shown in the middle highlighting the five forms of (in)consistency (C) as a double-pointed arrow along the adaptation planning and management cycle: consistency between risks of hazards and adaptation goals (C1)(blue), between sectoral risks and adaptation measures (C2)(brown), between risks for vulnerable groups and related measures (C3)(green), between measures for vulnerable groups and related monitoring and evaluation (M&E)(C4)(yellow), and between risks for vulnerable groups and participation (C5)(purple). Around the center, we see the results for a sample of 167 European cities that allow for the analysis of C1 to C5.12 In all panels, the potential adaptation gap is the degree of inconsistency (shown in rosé). For example, for C1 (top left), we see that two-fifths of cities with hazard/ risk information unearth a potential adaptation gap, i.e., identify risks/ hazards without a related adaptation goal. Substantial variation across hazards exists, particularly for landslides and wind/ storm changes, which are identified as a risk but not adequately followed up with an adaptation goal. It is remarkable that about a third of plans state an adaptation goal related to inland flooding without flooding being identified as a risk—the largest such inconsistency among C1. Detailed results for the other forms of consistency can be found in Supplementary Results 2. The average scores across C1 to C5 are shown at the bottom left.

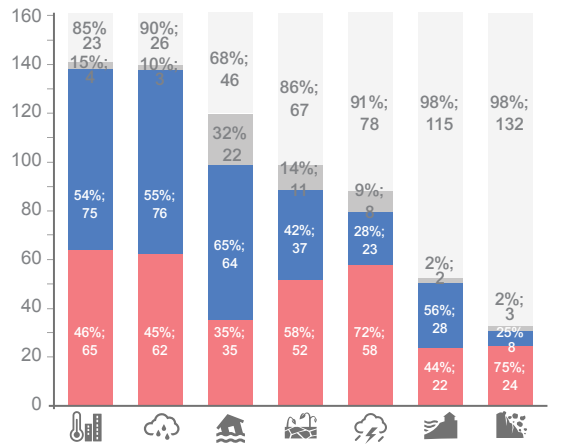
Fig. 2: Geographical representation of a potential adaptation gap. The conceptualization of the potential adaptation gap is shown in the middle highlighting the five forms of (in)consistency (C) as a double-pointed arrow along the adaptation planning and management cycle: consistency between risks of hazards and adaptation goals (C1)(blue), between sectoral risks and adaptation measures (C2)(brown), between risks for vulnerable groups and related measures (C3)(green), between measures for vulnerable groups and related monitoring and evaluation (M&E)(C4)(yellow), and between risks for vulnerable groups and participation (C5)(purple). Around the center, we see the scores of each form of (in)consistency as a regional distribution across the European continent. Each city is depicted by a colored bullet. The colors depict the form of consistency (blue–C1, brown–C2, green–C3, yellow–C4, purple-C5) as well as the degree (sums of all scores of bars in Fig. 1). Full consistency is colored in the respective C1 to C5 color; degrees of inconsistency—indicating a potential adaptation gap—are colored in shades of rosé [in %]. At the bottom left, scores show the average consistency per adaptation plan and city. Full consistency is given as green; degrees of inconsistency—indicating a potential adaptation gap—are shown in shades from green to red, with a maximum inconsistency of 79,6% of individual items checked, the highest score across individual cities. Key: NR – Not relevant, i.e. no consistency item identified in plan. Data: own coding; country borders were derived from World Administrative Boundaries - Countries and Territories (2024)[35].

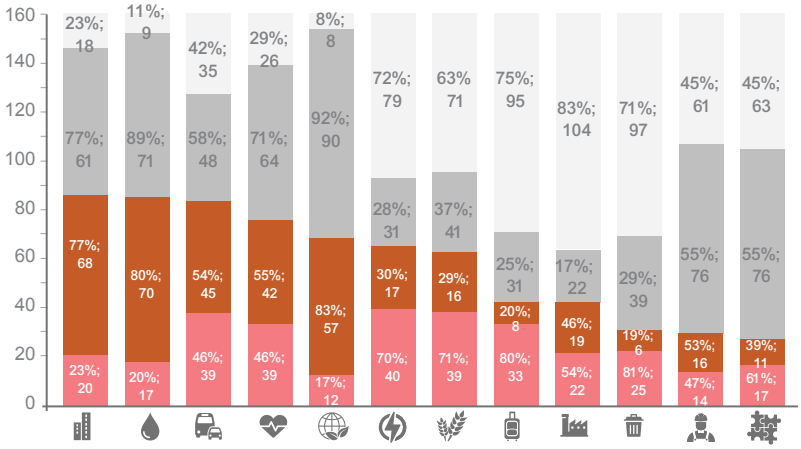
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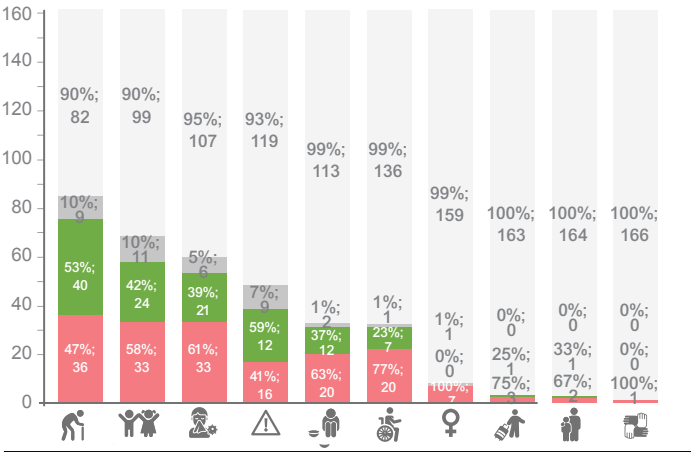
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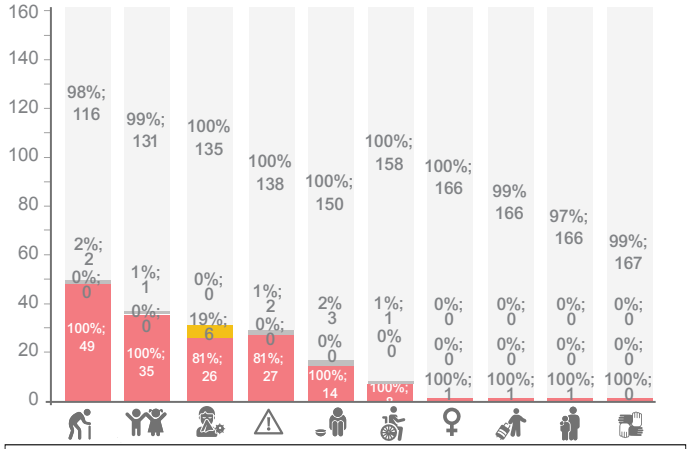
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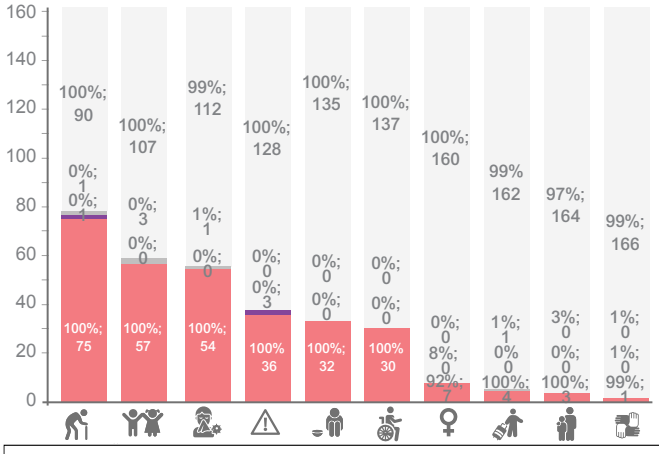

I.Fact base CC impact, risk and vulnerability assesment
C1
II.Adaptation goals
C2 C3
III.Adaptation measures
C5
VI.Participation
V.Monitoring & evaluation
C4
IV.Implementation tools, process & progress

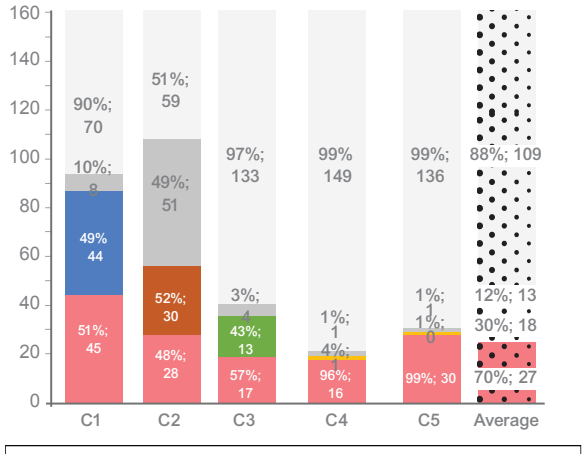

C1 | Risks from hazards and respective goals
Inconsistent Elements
Consistent Elements
No risk, BUT actions
No risk, no actions
Temperature
Precipitation
Storms & wind
Coastal floods
Inland floods
Drought
Landslide

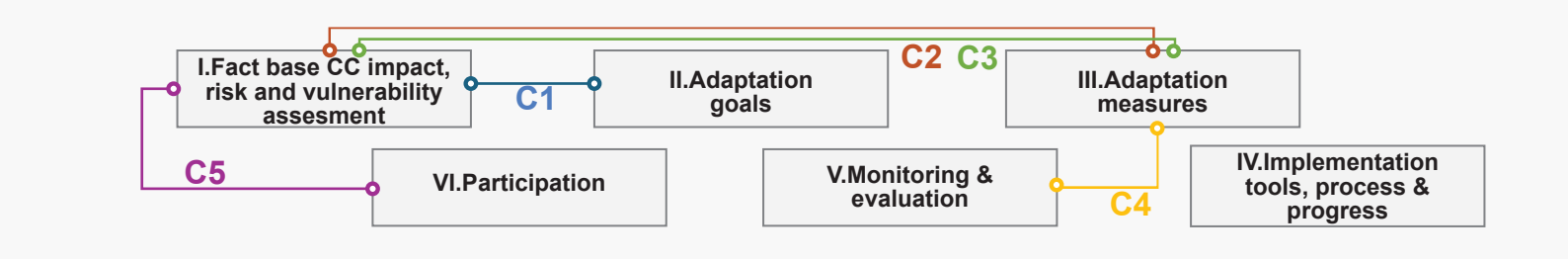

C2 | Risks for sectors and respective measures
Inconsistent Elements
Consistent Elements
No risk, BUT actions
No risk, no actions
Buildings
Water
Transport
Health
Environment
Energy
Agriculture
Tourism
Industies (General)
Waste
Civil Protection
Social institutions

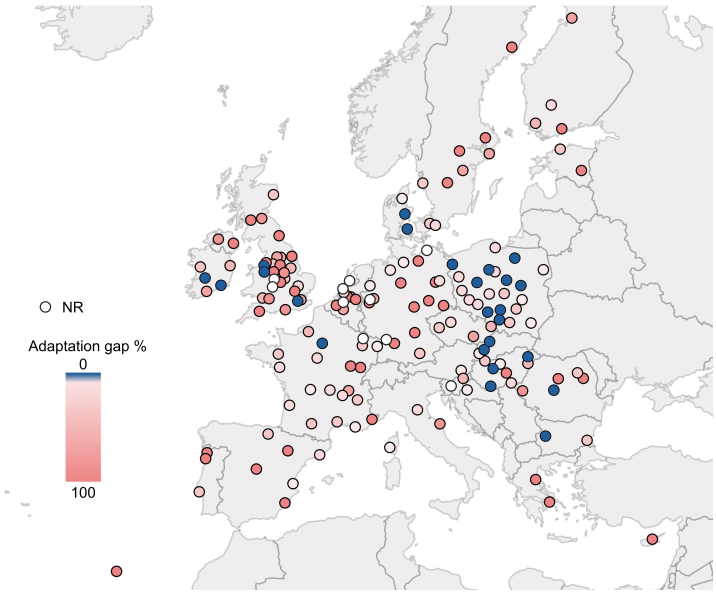

C3 | Risks for vulnerable groups and respective measures
Inconsistent Elements
Consistent Elements
No risk, BUT actions
No risk, no actions
The Elderly
Children
Sick People
"Vulnerable"
The Poor
Immobile People
Women/Gender
Migrants
Lone Parents
Ethnic Communities


C4 | Measures for vulnerable groups and respective M&E
Inconsistent Elements
Consistent Elements
No risk, BUT actions
No risk, no actions
The Elderly
Children
Sick People
"Vulnerable"
The Poor
Immobile People
Women/Gender
Migrants
Lone Parents
Ethnic Communities

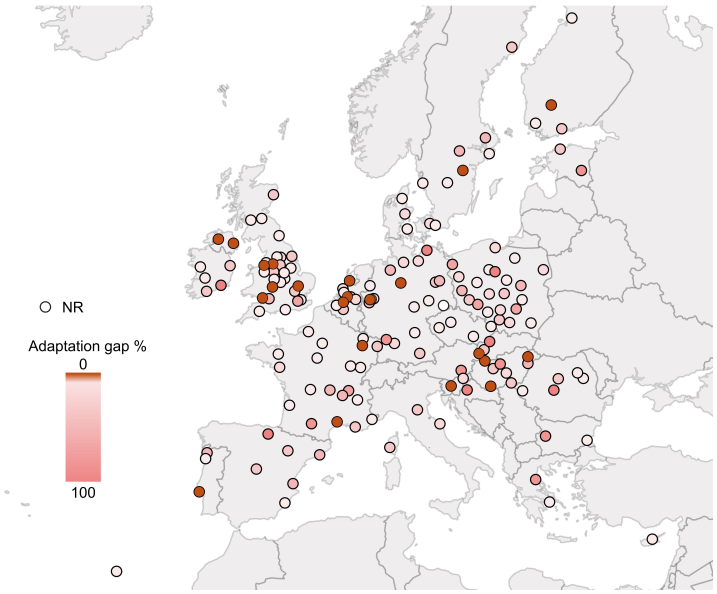

C5 | Risks for vulnerable groups and respective participation
Inconsistent Elements
Consistent Elements
No risk, BUT actions
No risk, no actions
The Elderly
Children
Sick People
"Vulnerable"
The Poor
Immobile People
Women/Gender
Migrants
Lone Parents
Ethnic Communities


C1
C2
C3
C4
C5
Average
C1-C5 | Average Scores
Inconsistent Elements
Action without consideration
Consistent Elements
No risk, no actions

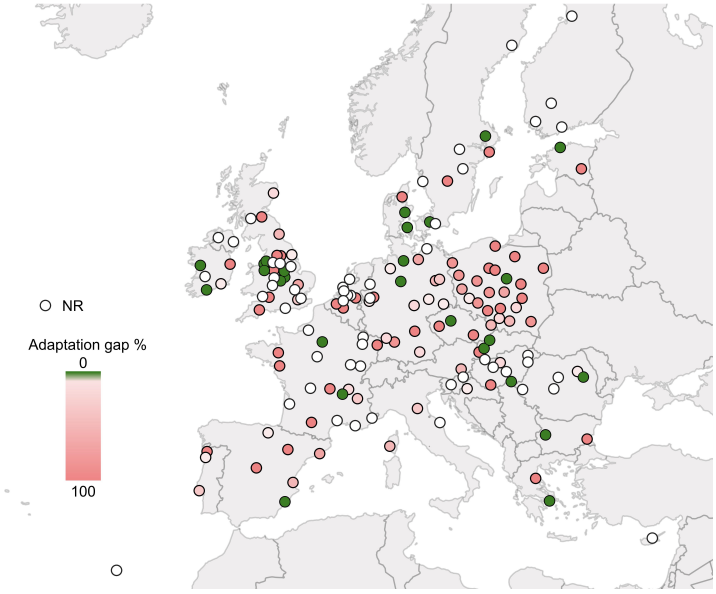




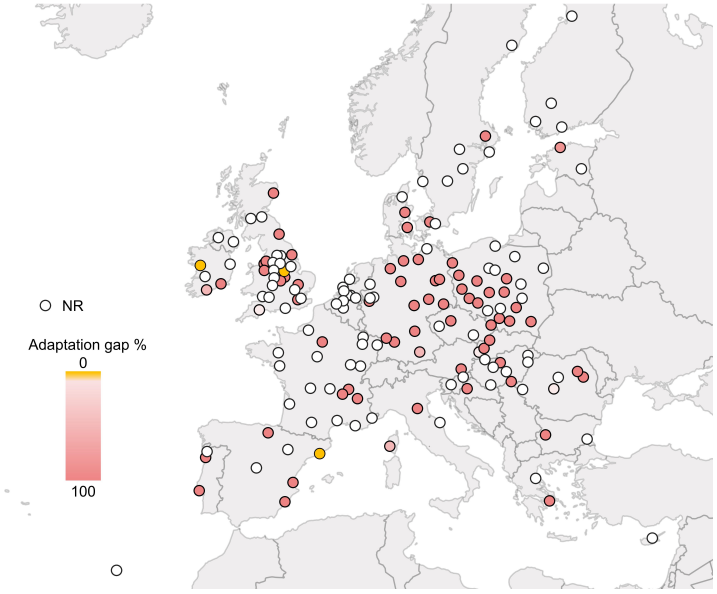
C1 | Risks from hazards and respective goals



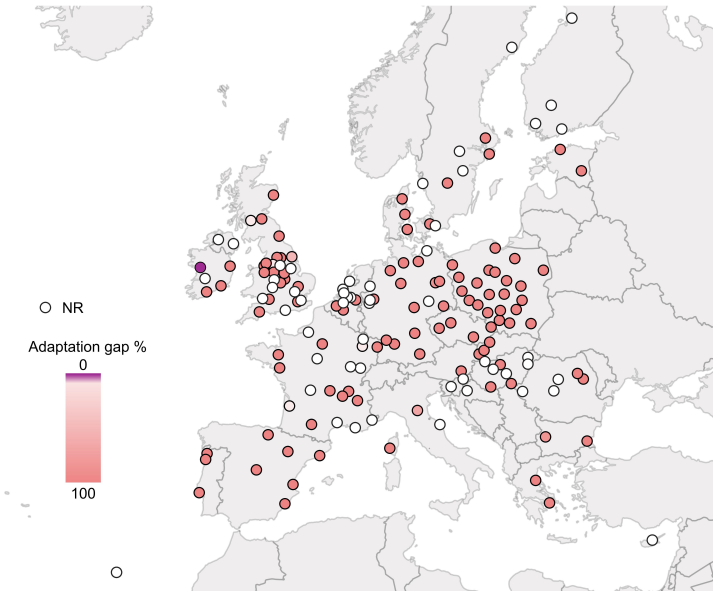
C2 | Risks for sectors and respective measures



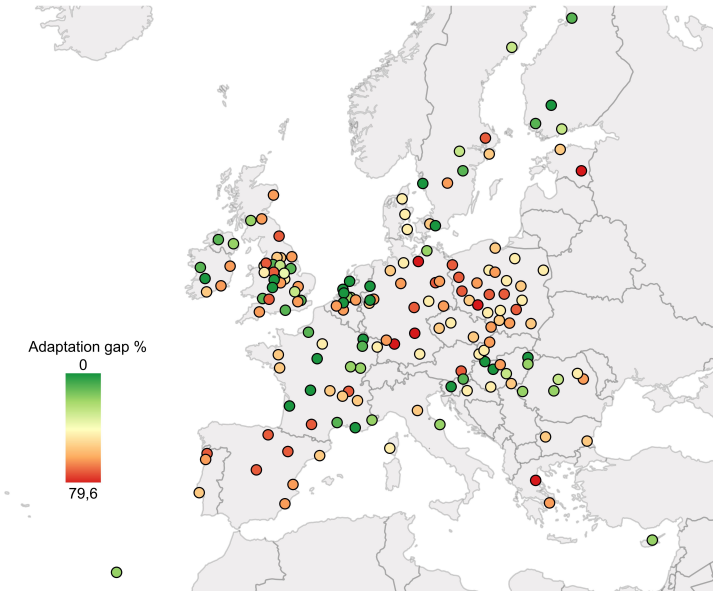
C3 | Risks for vulnerable groups and respective measures



C4 | Measures for vulnerable groups and respective M&E



C5 | Risks for vulnerable groups and respective participation



C1-C5 Average Scores