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172

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Climate change adaptation: a pragmatic approach for assessing vulnerability

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Abstract

The impacts of climate change on society are becoming increasingly evident. The water sector is sensitive to variations in climatic patterns as it is expected that major changes in flows will occur, along with increased risks of water quality degradation and flooding. According to published climate scenarios the Mediterranean area will become dryer. As a leading group operating in the water sector in Portugal, AdP decided to develop a strategic plan for climate change adaptation with the aim of establishing a strategy for reducing business vulnerability and increasing systems resilience. In developing the plan, a pragmatic method was adopted for characterizing current vulnerabilities. This was founded on the bottom-up approach and supported with past events data, including evaluating their impacts, and the adaptive capacity of systems and utilities to climate extremes. In water supply, the effects of more severe and frequent extreme events are being felt with respect to water quality and availability, representing as much as 80% of the events studied, whereas, in terms of sanitation, floods account for about 90% of events identified. Globally, 78% and 21% of the measures adopted in water supply and wastewater management, respectively, were effective.

Key words: climate change, pragmatic approach, risk assessment, vulnerability

INTRODUCTION

Climate change (CC) is of growing importance, as its impacts on society become increasingly evident globally. On the other hand, society has become more demanding and informed about CC, and the need for a global strategy for adapting to it. The water sector is thought particularly sensitive to variations in climatic patterns, as it is expected that major changes in annual and seasonal precipitation, and in water flows will occur, along with increased risks of flooding, coastal erosion and water quality degradation.

Published CC scenarios suggest that southern Europe – e.g., the Mediterranean area – will tend to become dryer, even though torrential rain events become stronger and more frequent, and regional scale freshwater discharges increase (IPCC 2014).

In this context AdP Group decided to develop a strategic plan for climate change adaptation (SPCCA), to establish short, medium and long-term adaptation strategies to reduce business activity vulnerability and increase systems resilience to climate change and extreme weather events. AdP Group currently includes 12 operational utilities with wide geographic dispersion in Portugal under different climatic conditions, so the project's aim was a common, Group approach, with specific analyses and measures for each utility.

Water Practice & Technology Vol 14 No 1
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CC adaptation measures often represent significant investments in order to support medium-term systems resilience. Thus, investment decisions must be well justified and explained in detail. This is particularly important in AdP's case as it is a state enterprise providing water and sanitation services to about 80% of the Portuguese population. The context underlines the need for and advantages of a quantitative analysis to support decision-making, incorporating the challenges and opportunities of CC into the business strategy planning cycle.

AdP SPCCA comprises two phases:

- Phase 1 – developing a strategic framework at corporate level;
- Phase 2 – developing a local, tactical plan for each regional utility.

This paper describes the methodology followed in assessing current vulnerabilities and climatic risks, during Phase 1, as well as the main results.

MATERIALS AND METHODS

During Phase 1 a pragmatic methodology was followed to characterise current vulnerabilities. This used a bottom-up approach – Figure 1 – supported by information about events that occurred in the previous 10 to 15 years, including evaluation of their impacts, and the adaptive capacity of systems and utilities.

Information about past events was captured systematically using a specially developed database tool. In order to ensure that the tool was used properly, a series of meetings with focal points identified in each utility was promoted by a team from AdP. The team also analysed the results, providing a vulnerability assessment in the short-term for each utility. This included measuring and characterising

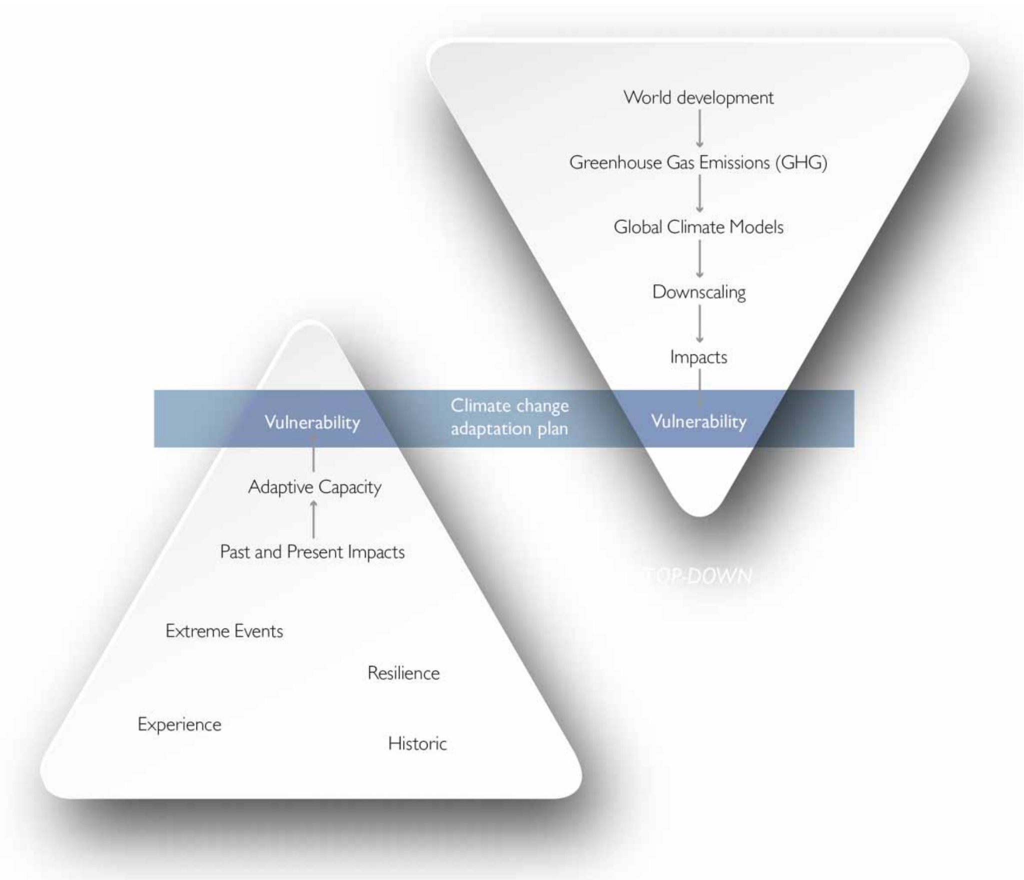

Figure 1 | Top-down and bottom-up approaches, complementary approaches to understanding vulnerability and its role in climate change adaptation (Adapted from Dessai & Hulme 2004).

Water Practice & Technology Vol 14 No 1
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the exposure, sensitivity, and adaptive capacity of AdP utilities to past events. Additionally, the climate risk was estimated using the frequency of past events as a proxy for probability. This methodology was based on the general definition of risk (IPCC 2014), adapted to the constraints of the bottom-up approach and the information available (Figure 2).

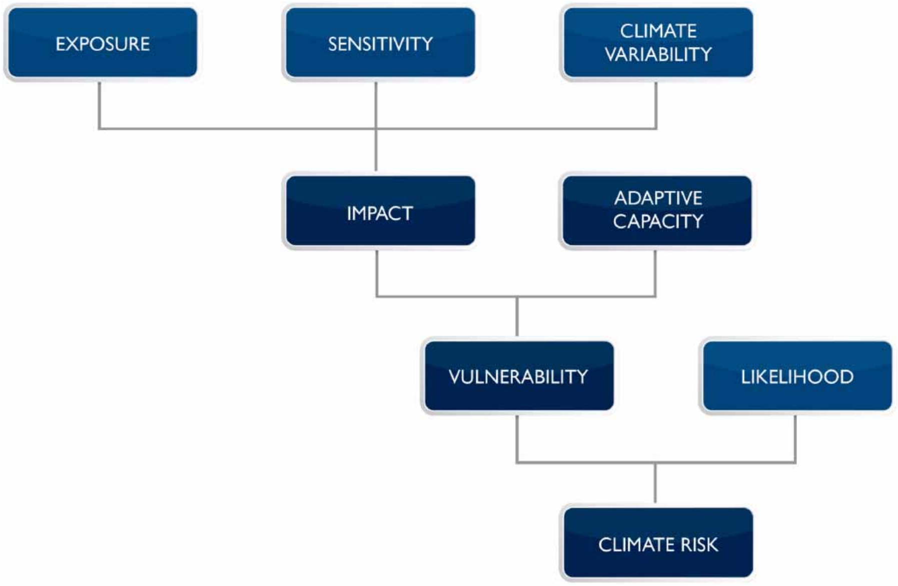

Figure 2 | Adopted methodology, based on the general definition of risk.

RESULTS AND DISCUSSION

The bottom-up approach used in Phase 1 enabled:

- identification and evaluation of past extreme weather events, and of their impacts in the water supply and wastewater systems;
- identification and evaluation of the systems' response and recovery capacities to these events;
- identification and evaluation of the systems' current vulnerabilities and risks in relation to extreme weather events; and,
- systematisation of a portfolio of adaptation measures and actions to respond to extreme weather events.

Figures 3 and 4 present the results relative to various past events and different signalling areas, and the severity of those events' impact.

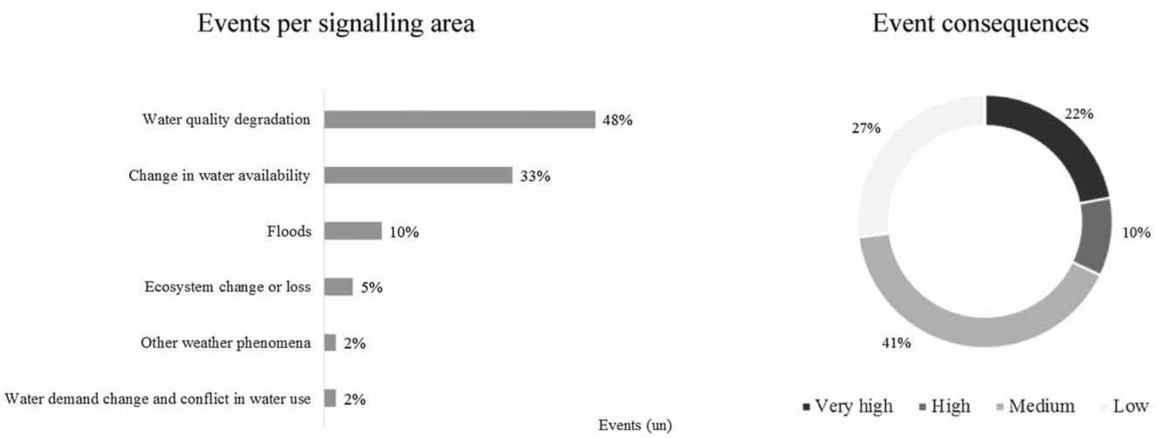

Figure 3 | Events per signalling area (left) and event consequences (right) – water supply systems.

Water Practice & Technology Vol 14 No 1
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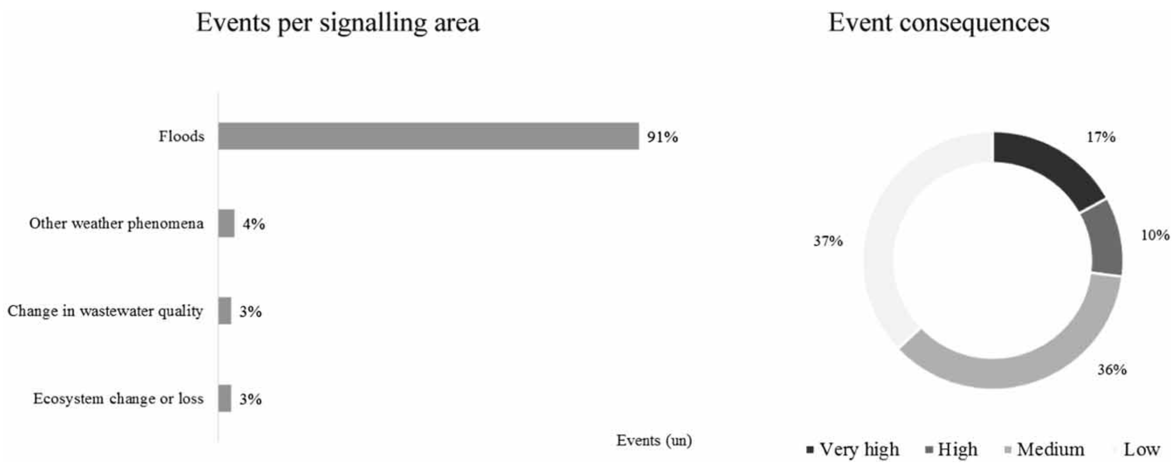

Figure 4 | Events per signalling area (left) and event consequences (right) – sanitation systems.

As expected, in relation to water supply, the effects of more severe and frequent extreme events are being felt in terms of both water quality and availability, for up to 80% of events. In sanitation, floods account for about 90% of identified events. On the other hand, the country's geographical heterogeneity emerged clearly in both the nature of the events impacting on the systems and the severity of those impacts.

Figure 5 presents the water supply systems' response and recovery capacity to these events.

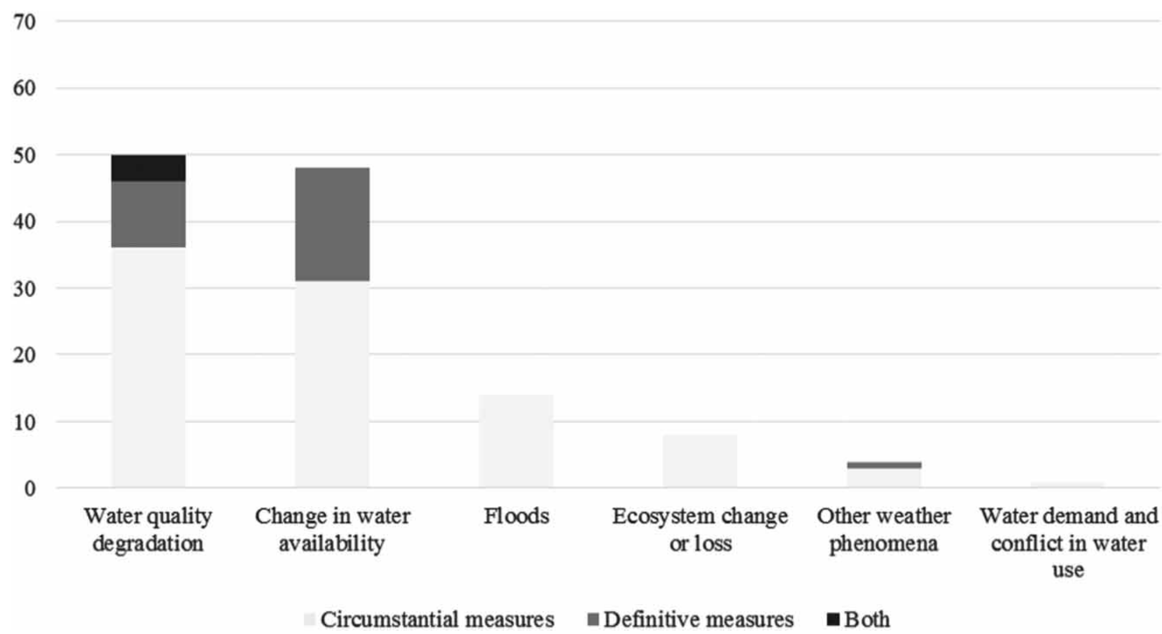

Figure 5 | Water supply systems' response to the events identified.

In water supply, the systems' response to the effects of extreme events related to water quality and availability represent up to 78% of the measures adopted. Of these, 68% were circumstantial measures like changing water intake locations, using complementary treatment steps or increasing reagent dosage. Other measures included water use restrictions. Definitive measures represented 28% and included linking different water systems, to diversify water sources and reinforce system resilience. Some 78% of the measures adopted were effective.

Figure 6 shows the wastewater collection and treatment systems' response and recovery capacity to these events.

Water Practice & Technology Vol 14 No 1
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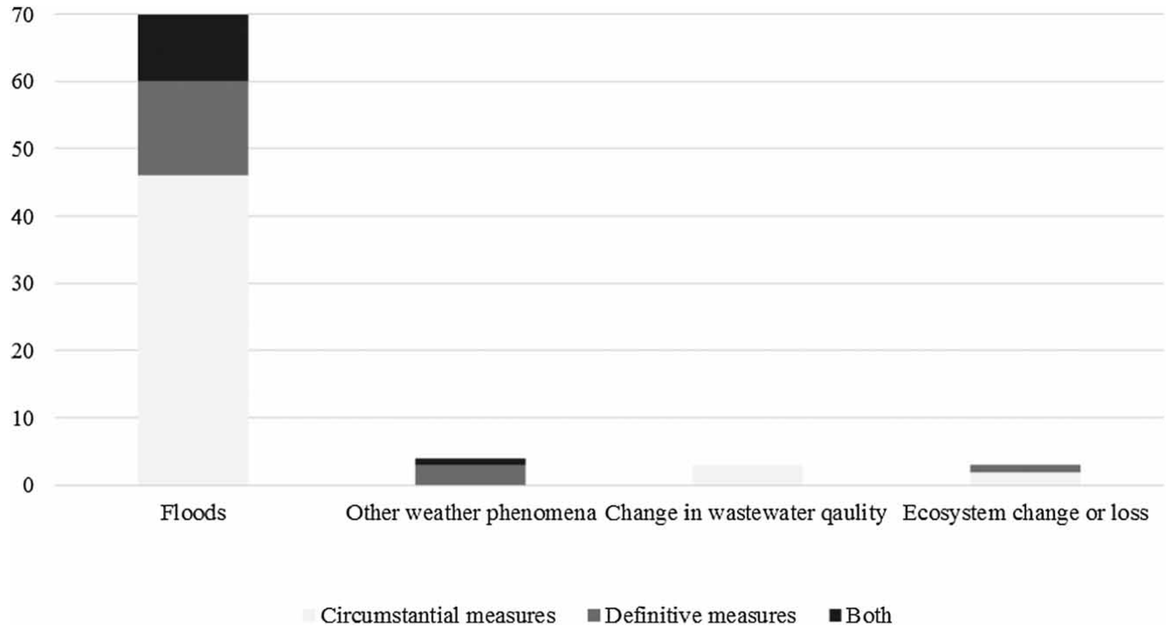

Figure 6 | Sanitation systems' response to the events identified.

Almost 90% of the wastewater measures were intended to respond to flooding, mainly due to long-lasting rain and/or raised river levels, or storms and consequent flash-flooding. Of these, 21% were effective. In most cases (57%), the solution adopted was service interruption to avoid further damage. Another outcome of the analysis was the finding that 16% of the measures adopted comprise plant repairs, enabling service restoration to that prior to the event, but not improving resilience for the future.

The impact and adaptive capacity analysis made it possible to systematise information on past events, including lessons learned, as well as the challenges to systems and business. This enabled understanding of the vulnerabilities and climate risks that AdP utilities face now, and their ability to cope with extreme weather events.

At national level, in water supply, the events with highest climatic risk are those linked to decreasing water availability and to water quality degradation. In wastewater collection and treatment, the events with the highest climatic risk are floods, because of increased watercourse flow and velocities. In this last case, the high risk classification level arises, generally, from the high rate of service interruption during and after floods.

This structured characterisation and climate risk analysis will enable identification of priority areas of intervention that would lead to the introduction of cost-effective adaptation measures to be implemented in Phase 2. With this in mind, a portfolio of adaptation measures was established, based on utilities' feedback and bibliographical research, and made available in Phase 1. The adaptation options were divided into 'soft' (non-structural) and 'hard' (structural) measures, with priority given to the first, because of both the (typically) lower cost and their flexibility.

CONCLUSIONS

AdP is developing its Strategic Plan for Climate Change Adaptation because the Group recognises that risks from future climate change and extreme weather events are of real concern for the water sector. The work that the Group has done during Phase 1 of the plan, by applying the pragmatic, bottom-up approach is described in this paper.

The approach enabled characterisation of past events, their impacts on facilities, and the systems' response, representing a solid baseline for understanding AdP utilities' current vulnerabilities in the face of extreme weather events.

Water Practice & Technology Vol 14 No 1
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In water supply, the water availability and quality vulnerabilities identified, combined with medium-term projections of water demand, permits anticipation of the areas where future scarcity problems are likely to become worse.

In wastewater collection and treatment, knowledge of past events enables identification of the systems most susceptible to floods impacts, which is particularly important in the face of the potential increased frequency and magnitude of extreme weather events.

The measures identified and implemented by utilities in response to past weather events were an important contribution to the development of a portfolio of adaptive measures that can be replicated within the Group.

Special attention must be paid to measures related to governance, regulation and communication with/between stakeholders, as these play an increasingly important role in utility management activities. Debate between stakeholders is essential, in fact, as climate change impacts do not follow sectoral boundaries, and the urban sector represents only a small part of water demand when compared with others like agriculture.

The bottom-up approach adopted will be complemented with a top-down approach, using climate and socio-economic trends and scenarios provided by the Portuguese Environment Authority, which is also responsible for the national climate change strategy. These future trends, together with the vulnerabilities already identified, will enable a sustained understanding of the expected evolution of the vulnerabilities and risks for each system in the medium- and long-term.

Nevertheless, the authors believe strongly that a bottom-up approach is a pragmatic and easily used tool to support climate change adaptation strategies. It is based on existing information, and can show utilities' current vulnerabilities and exposure to present and future climate risks. It is also supported by an integrated process involving collaborative approaches with stakeholders.

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