

## Abstract

Increasing greenhouse gas emissions means adaptation to a changing climate is becoming increasingly urgent. This is widely recognized and policies are being developed and implemented worldwide, across sectors, and between governmental scales globally. The aim of this paper is to reflect on one of the major challenges; facilitating and sharing of information on best/next adaptation practice. Web portals for information dissemination are important tools in meeting this challenge and therefore we assessed the characteristics of selected major portals across multiple scales. We found that there is a rather limited number of case studies available in the portals, in total between 900 and 1000 - with 95 including cost information, and 195 including the participation of stakeholders, globally. Portals are rarely cited by researchers suggesting a suboptimal connection between the practical, policy and science development of adaptation. The governmental portals often lack links on search result between e.g. U.S. and EU portals. With significant investments and policy developments emerging in both U.S. and EU there is a large potential to share information via portals. There is moreover a potential to better connect the practical adaptation experience from bottom-up projects with the science of adaptation.

## Introduction

The seriousness of the climate change impacts on socio-economic and environmental systems has forced governments around the world to consider how to most cost-effectively adapt to the more frequent extreme weather-related risks and changing climatic conditions. Adaptation needs are both related to protection of human health (e.g. disaster risk reduction) and ecosystem services (e.g. adapting agricultural practices and policies), and protection of human infrastructure in general (e.g. protecting cities against flooding). Restricting the average global temperature increase to no more than 2°C during this century relative to pre-industrial times is still the official mitigation policy benchmark; e.g. of the UN 'Copenhagen Accord' from COP15, and also the point of departure for the COP 21 meeting in Paris later this year to prevent serious and dangerous climate change impacts (<http://unfccc.int/2860.php>). The window for limiting the global surface temperature rise to this limit is however rapidly diminishing. The United Nations Environment Programme (UNEP) (2013) estimates that to meet the 2°C target with the least costs would mean emissions in 2050 that are 41% and 55%, respectively below the emissions in 1990 and 2010. By 2020 global emissions should be reduced by  $17 \pm 3$  GtCO<sub>2</sub>. However, the global reduction pledges does not amount to this - at best the emission gap would be 6 GtCO<sub>2</sub>. The COP21 agreement concludes that the current intended CO<sub>2</sub> emission reductions in 2030 will result in annual global emission of 55 GtCO<sub>2</sub> (paragraph 17), this needs to be further reduced to 40 GtCO<sub>2</sub> to meet the 2°C target in 2030. Anderson and Bows (2011) hence found that there is now little or no chance of maintaining the rise in global mean surface temperature at or below 2°C, despite repeated high-level political statements to the contrary. Betts et al. (2011) concluded that their best estimate is that a 4°C global temperature rise compared to pre-industrial levels will be reached in the next 50-60 years. It is therefore increasingly evident that climate change adaptation is becoming progressively important at a global scale to protect against potentially more extreme and frequent weather

events/risks (e.g. recent hurricanes Bopha/Pablo, Sandy, Haiyan), and also for the gradually changing climatic conditions, e.g. for agriculture under a potential 4°C scenario (New et al. 2011).

In light of the above, adaptation to climate change is becoming increasingly important from a humanitarian and economic point of view. Adaptation can in essence be seen as the societal reaction to climate change to cope with current climate changes or anticipated ones related to extreme weather events (e.g. increased rainfall, scarcer water resources, more frequent storms, etc.), as well as gradual change, for example in new disease and pest patterns and in ecosystem service provision (Adger et al. 2007). The UNFCCC (2015) has defined adaptation as the adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damage or to benefit from opportunities associated with climate change (<http://unfccc.int/focus/adaptation/items/6999.php>) Autonomous adaptation will occur - but the advancement and application of science in the areas of climate, impacts, society and economics, should enable proactive science-based planning of adaptation to climate change that cost-effectively minimizes environmental, social and economic disruption. There is hence a need for sound data and information sharing to support decisions that increase adaptive capacity. Adaptation planning is thus a knowledge intensive process (Juhola and Westerhoff 2011)

There is a burgeoning database industry in the area of climate change research and also in the area of adaptation, particularly as climate change research has entered the realm ‘big-data’ and ‘big-science’ across the world (*Editorial Nature CC. 2012*). Decision makers are therefore generally faced with ever-growing information sources and amounts, especially in the area of adaptive management where the value of information is a very important steering tool (Keisler et al. 2013). Data is being shared globally via adaptation web portals (Carroll & Lambat, 2013), with the ambition of sharing and linking knowledge, and to facilitate adaptation measures. In 2015, the

European Environment Agency published a report providing an overview of the European adaptation portals (EEA, 2015) in terms of their challenges and strengths. Portals have moreover been developed by individual projects, authorities, various communities and even interested individuals.

It is not self-evident that the knowledge delivery corresponds to the perceived needs of those preparing adaptation action. Adaptation consists of at least five general components: observations; assessment of impacts and vulnerabilities (risks); planning; implementation; and monitoring and evaluation of adaptation measures. Effective involvement and engagement of stakeholders and management of knowledge for adaptation is vital in supporting all adaptation activities, at each step in the process. Under the [Cancun Adaptation Framework](#), relevant multilateral, international, regional and national organizations, the public and private sectors, civil society and other relevant stakeholders are invited to undertake and support enhanced action on adaptation at all levels (<http://unfccc.int/focus/adaptation/items/6999.php>). It is clear from this development that, an accurate assessment of the risks, effective planning by involving the stakeholders (participation), and cost-effective measures are key for successful adaptive planning. However, the usability of such knowledge arguably depends on the extent to which it can be applied to the local context and scale, and thus the degree to which the stakeholders – as key implementers and knowledge users and providers - can participate in both the knowledge generation and decision making processes. The extent to which these factors – cost assessments and stakeholder participation - are considered and reported in key online tools and knowledge portals is investigated in this paper.

Our aim with this paper is to provide a brief presentation of selected knowledge portals that have been set up to support adaptation. In so doing we seek to assess the number of case studies (e.g. adaptation in a city where the measures, processes, and results are presented) available

in the portals with a focus on critical decision support relevant information, namely, cost assessments and stakeholder participation consideration for the implementation of the adaptation plans as key components of successful adaptation planning. We selected the major portals primarily from the U.S. and EU, and we used them as an entry to state and country specific portals. Lastly we included three international portals, see Table 1. We then proceed to examine a selection of online portals from different jurisdictions and discuss their use and contents at a general level.

A uniform motivation underlying the establishment of portals is that policy development around critical societal and environmental issues like climate change should be based on sound science and an informed democratic process for decision making (OECD 2002). Adaptation is needed in virtually all sectors, there are however, serious scientific gaps and challenges as to the delivery of decision-relevant science to the decision-makers. One of the areas in which there is a knowledge gap is the field of adaptation case studies where there has been little comparative and evaluation research (Moss et al. 2013). Moss et al (2013) note that a number of portals with adaptation lessons are emerging (e.g. the ones in this paper), but that a particular challenge in academic research on adaptation research is learning from adaptation practice to thus contribute to a cumulative adaptation science, and by extension science-based adaptation policy- and decision-making. Hence, for climate change adaptation and national strategies to fulfil this requirement of enhanced resilience, there is a strong need for sharing (e.g. via the internet) policy relevant information (e.g. economic analyses of adaptation measures), and to involve the local community whose lives are being affected by the measures taken. Viner and Howarth (2014) also pointed towards the problem that the academic community primarily are not effective in including practitioners in the systematic review of evidence, and note that the lack of integration hinders full and realistic assessments of available evidence - thus illustrating a disconnect between science and practitioners as a barrier in the area of adaptation development.

In terms of value of information in an adaptive management context, which climate change adaptation often is, information about costs and participation are critically important for cost effective adaptation planning as outlined by the UNFCCC above. Such information is quantitatively accessible via adaptation portals containing case studies that address these experiences, and were therefore our focus points in the present paper.

**Results:**

We examined the direct links to scientific knowledge of the portals as indicated by hits and citations in Google Scholar and Web of Science to quantify the suggestions by Moss et al (2013) and Viner and Howarth (2014) on lack of connection between practitioners and academics. We used the total number of case studies which report analysis of costs and stakeholder participation as indicators of decision relevant contents and valuable/useful information (Keisler et al. 2013) in an adaptive management context (Tab 1).

Table 1: Analysis of climate change adaptation portals. Data on sites linking in and google-scholar (November 2015)

<b>Portal</b>	<b>Total # adaptation case studies</b>	<b># Adaptation case studies with CBA and participation</b>	<b>Sites linking in</b>	<b>Google Scholar hits</b>
US: climate change: <a href="http://www.epa.gov/climatechange/">http://www.epa.gov/climatechange/</a>	0	0	NA	3 420
US: adaptation: <a href="http://www.epa.gov/climatechange/impacts-adaptation/adapt-tools.html">http://www.epa.gov/climatechange/impacts-adaptation/adapt-tools.html</a>	0	0	NA	0
US: California: <a href="http://cal-adapt.org/">http://cal-adapt.org/</a>	0	0	62	13
US: George Town: <a href="http://www.georgetownclimate.org/adaptation/clearinghouse">http://www.georgetownclimate.org/adaptation/clearinghouse</a>	170	29+69	140	3
US: CAKEX: <a href="http://www.cakex.org/">http://www.cakex.org/</a>	307	27+94	152	84

EU: <a href="http://climate-adapt.eea.europa.eu/">http://climate-adapt.eea.europa.eu/</a>	66	18+13	NA	34
EU: UK: <a href="http://www.ukcip.org.uk/">http://www.ukcip.org.uk/</a>	~150*	0+1	254	835
EU: Denmark: <a href="http://en.klimatilpasning.dk/">http://en.klimatilpasning.dk/</a>	34	0+0	87	55
EU: Finland: <a href="https://ilmasto-opas.fi/en/">https://ilmasto-opas.fi/en/</a>	8	2+2	53	67
WHO: <a href="http://www.who.int/topics/climate/en/">http://www.who.int/topics/climate/en/</a>	0	0	NA	18
United Nations: <a href="http://unfccc.int/adaptation/items/4159.php">http://unfccc.int/adaptation/items/4159.php</a>	~100*	0+0	NA	39
weADAPT: <a href="http://weadapt.org/">http://weadapt.org/</a>	68	21+16	80	111

\* UKCIP and UNFCCC are approximate as the exact number is difficult to determine precisely from the website.

Some of the webpages were not assessable by Alexa as they were sub-pages of larger organizations web portals (USEPA; EEA; WHO; UNFCCC). In terms of global ranking the portals were overall not very high. Another indicator of the use of the portal is provided by the information on the number of sites that link to it. The UKCIP, Georgetown and weADAPT have the highest number of links in. The lowest number of links has been established to the portals from California, Denmark and Finland. The Google Scholar hits suggest that the US EPA, UKCIP and weADAPT are the most well-known sites in the scientific community, but overall the portals get few references in the scholarly literature. This was confirmed by the search on Web of Science, which did not provide a single reference to any of the portals. In terms of the adaptation case study content, CAKEX has the largest database and also most studies which address costs and stakeholder participation. There is most likely an overlap with the Georgetown database as the portals cross-link. In Europe the Climate-Adapt portal appears to contain most studies that are relevant with regards to costs and participatory approaches, although other portals have more case studies (e.g. UKCIP). Among the more project oriented portals weADAPT contains 21+16 studies on costs and stakeholder participation, respectively.

Cases with cost information and participatory approaches represented a small proportion of the total number of case studies in the portals. However, neither the number of cases nor their contents seemed to affect the Google scholar hits. This suggests that most users of the portals have looked for other information than that provided in the case descriptions. There were no explicit links between the U.S. and the EU portals. This may reflect the view that adaptation has been considered to be highly geographically context specific in terms of the local social, economic, environmental and political conditions. The patterns that emerged from the comparison of the portals (Table 1) probably have many different explanations. In terms of sites linking to the portals the small countries did score low, as one would expect due to language. The scholarly references to the portals were highest for the US EPA and the UKCIP – these are of course also older and more academically established than most of the other. A detailed analysis of references to these portals in the academic literature is beyond the scope of this paper, but a preliminary examination suggested that one reason for scholars to refer to the portals was that they can contain specific documents that may be difficult to retrieve from other places. For example, Wheeler (2008) referred to “State climate action plans: [http://www.epa.gov/climatechange/wycd/stateandlocalgov/state\\_action.html](http://www.epa.gov/climatechange/wycd/stateandlocalgov/state_action.html).” Another reason for citing portals was their role as a repository for specific tools or models. For example, Berry et al. (2002) referred to “UKCIP Technical Report. UKCIP, Oxford. [http://www.ukcip.org.uk/model\\_nat\\_res/model\\_nat\\_res.html](http://www.ukcip.org.uk/model_nat_res/model_nat_res.html)”. Kirchhoff et al (2013) moreover, explained how UKCIP is a recognized successful boundary/interface between science and practice. As the US Climate Data Initiative (CDI) is under development the current primary information portals on adaptation in the U.S. are: Georgetown Climate Centre; US EPA has two webpages; and the Climate Adaptation Knowledge Exchange. There is moreover, a portal with a map that shows how cities and states are adapting (or becoming more resilient) to their individual vulnerabilities. The map is not a comprehensive compilation of every city plan or action, but rather highlights

concrete adaptation actions and examples of what both large and small U.S. cities are doing to adapt to a changing climate (<http://www.c2es.org/us-states-regions/policy-maps/adaptation>). Portals that have included contents which have been directly used in scientific work and have received more scholarly references than those which have contained, for example, case descriptions or practical advice on how to carry out adaptation.

Overall our analysis suggests that the academic use of the portals, e.g. case study content, is still somewhat limited, thus quantitatively confirming the qualitative observations by Moss et al (2013) Viner and Howarth (2014) - that integration of practitioners research and academic research could be improved, at least from an academic point of view. The databases that the portals include are probably mostly used by the decision makers and stakeholders who have also been perceived to be the primary audience for the portals.

The limited impact of portals thus far in this context is not surprising as such. As far back as in the late 1970s Weiss (1979) coined the phrase the ‘problem of little effect’ where policy relevant knowledge is generated but not picked up by decision making processes. It might be that demand for the information they contain may be limited because adaptation planning is still in its infancy (Ford et al 2011). Another factor might relate to the perceived usability of the data in relation to the needs of decision makers and stakeholders (Frazy et al 2013) in terms of perceived robustness, data format, value of information, fit with the adaptation context, etc. The low academic use of the portals might also suggest a low profile of these portals, in that they are not developed with researchers as the target audience and the researchers have not been aware of them in general, as well as the limited number of other websites linking into them. Further research into the use and usefulness of portals is needed to concretely determine what is driving the patterns we have observed in this paper. Such research is vital to ensure that the portals are appropriately targeted to decision maker needs to enable them to fully utilize and share knowledge and experience for more

robust and inclusive adaptation planning. In addition it is obvious that it takes time for a portal to establish itself as an important source of information. Persistence in developing and maintaining the portals is therefore crucial. The community based portals (for example CAKEX, weADAPT) have a clear strength in that a large group can contribute to the development. Portals which function as repositories of specific methods and official documents are also likely to be able to attract attention of a wide user community, including decision makers, practitioners at many levels, and researchers.

### Concluding reflections

There is clearly a need for better information sharing with regards to adaptation, especially with regards to high value information in support of decision and policy making on implementation/participation and regarding the economics of adaptation. There is moreover, a need to connect practice-oriented research from real world case studies and policy making to the scientific research in adaptation. It is also necessary to share adaptation information on a global scale and certainly between the EU and U.S. e.g. by linking portals as a starting point. Similarly, other regions could also benefit from combining or linking e.g. for drought-prone, flooding-prone, regions and countries; countries with similar socioeconomic and political status, etc

We have presented the portals that cover key elements of climate change impact, vulnerability and adaptive capacity with a focus on the currently most relevant ones in this paper. It is an additional and active research step to make the portal salient for those who may need information in drafting and implementing policies, or planning and executing measures that improve adaptive capacity locally or regionally (Kirchoff et al. 2013). There is an obvious potential for making interesting comparative analyses of the contents, development and use of portals between countries and in particular across the Atlantic, and to share lessons and link resources

between the EU and the U.S., especially in light of the ongoing Climate-ADAPT and the Climate Data Initiatives (<https://www.data.gov/climate/>) in the EU and U.S., respectively. It is moreover quite clear that effective, empirical and science-based adaptation is needed in light of the current CO<sub>2</sub> emission gap and therefore increasing adaptation needs, and the relatively few case studies addressing core decision-relevant information (Kirchhoff et al. 2013) (e.g. costs information and applicability/participation experiences in the field of adaptation). It is our hope that this paper can further facilitate covering the science gaps identified by Moss et al (2013) and Viner and Howarth (2014) by pointing to the largest clusters of case studies available globally in this paper.

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