Combined workshop on Regional Adaptation Strategies (17 June 2009) and Climate Vulnerability Indicators (18 June 2009)

Background Paper on Climate Vulnerability Indicators

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1. Introduction

The European Commission recently presented a White Paper outlining the framework for adaptation measures and policies to reduce the European Union's vulnerability to the impacts of climate change. Phase 1 (2009 to 2012) will lay the groundwork for a more comprehensive strategy to be implemented during phase 2 (2013 onwards). Two key elements of the action plan under phase 1 are to

- encourage the further development of National and Regional Adaptation Strategies with a view to considering mandatory adaptation strategies from 2012;
- develop indicators to better monitor the impact of climate change, including vulnerability impacts, and progress on adaptation by 2011.

This two-day workshop will present initial results from two projects initiated to help meet the objectives of the White Paper. On the first day (17 June), regional climate adaptation strategies will be discussed. We will debate the future process of regional adaptation to climate change. The specific objectives of this day are:

- To present and discuss the current EU situation with regard to the regional climate adaptation strategies; and
- To present and discuss guidelines to support regions to develop climate adaptation strategies

On the second day (18 June), the discussion will be about assessing and developing vulnerability indicators for the EU. The specific objectives of Day 2 are:

- To present and discuss the findings of the literature review and data scoping exercise; and
- To review and discuss a set of options for the further development and elaboration of vulnerability indicators across the EU.

This combined event provides the opportunity for National, Regional and local authority representatives, experts and European Commission services to discuss initial findings from both projects and consider their role in facilitating adaptation across the EU. There are links between the projects and the event will help understand the potential role vulnerability indicators could play in the development and implementation of adaptation strategies and also some of the challenges faced by decision-makers in identifying appropriate responses.

This paper provides an introduction to the project, "**Preliminary assessment and roadmap for the elaboration of Climate Change vulnerability indicators at regional level**." It provides the context for the project, sets out key concepts, reviews work to date, and provides an outline of what will be covered at the workshop. Also included are some initial questions for participants to consider in advance of the workshop.

2. Why is this project on vulnerability indicators underway?

The White Paper on Adapting to Climate Change, published by the Commission in April 2009 provides the immediate policy context to the requirements of this project. The White Paper sets out a framework to reduce the EU's vulnerability to climate change over two phases. Phase 1 identifies four pillars of action for EU adaptation policy:

- Strengthening the knowledge base;

- Mainstreaming adaptation into EU policies;
- Employing a combination of policy instruments;
- Developing international cooperation on adaptation.

It also commits the European Commission to developing indicators to "better monitor the impacts of climate change, including vulnerability impacts and progress on adaptation by 2011".

In parallel there is also work ongoing by the European Environment Agency to explore adaptation and vulnerability indicators. An expert group met to discuss this topic in Budapest (September 2008) and will reconvene in early July 2009. Following the first meeting, the EEA work has focused on the development of adaptation indicators (rather than vulnerability) and started to field test some of the ideas and methods discussed.[1]

The topic of vulnerability and vulnerability indicators has been explored within academic studies although the majority of work has been conducted within a development context. The recent international climate change conference (Copenhagen, March 2009) included a session on measuring adaptive capacities[2]. This brought together academics and practitioners from a wide range of interests and both developed and developing world contexts. Papers covered many aspects from data issues to conceptual issues. One consensus that emerged was that while there are tools and datasets in existence that are relevant to measurements of adaptation, adaptive capacity and vulnerability, in order to define clearly any useful or meaningful metric (or indicator), the purpose of the intended monitoring effort or evaluation study should be clearly stated first.

The aims of this project (which started in December 2008 and will finish September 2009) are to:

- collect the existing information on vulnerability indices, and assess their advantages and disadvantages;
- assess the feasibility and provide options for the design of a (set of) vulnerability indicator(s), that could be used to assess further EU-wide adaptation policy packages. It would require bringing together indicators at economic, social and environmental levels for different CC scenarios, available at NUTS-1 or NUTS-2 levels;
- provide a first version of one option for a (set of) indicator(s) with available data;
- assess the options for the further use of this (set of) indicator(s) for a number of EU policy aims.

To date the project has:

- conducted a literature review of previous studies on climate change vulnerability indicators;
- undertaken a data scoping exercise to identify possible sources of information for the development of vulnerability indicators in the short term (2009 to 2013) and in the longer term. This included a number of 'working sessions' with Commission services and the EEA.

[1] Technical Paper from the EEA's Topic Centre is available at http://air-climate.eionet.europa.eu/reports/ETCACC_TP_2008_9_CCvuln_adapt_indicators

[2] "Climate Change: Global Risks, Challenges and Decisions", Copenhagen, 10–12 March 2009. All abstracts for Session 36 "Approaches to Measuring and Enhancing Adaptive Capacities" are available on the conference website at http://climatecongress.ku.dk/abstractbook/ and the conference synthesis report is expected to be published soon.

- developed in outline a number of possible options for vulnerability indicators based on a number of potential policy objectives consistent with actions identified in the White Paper.

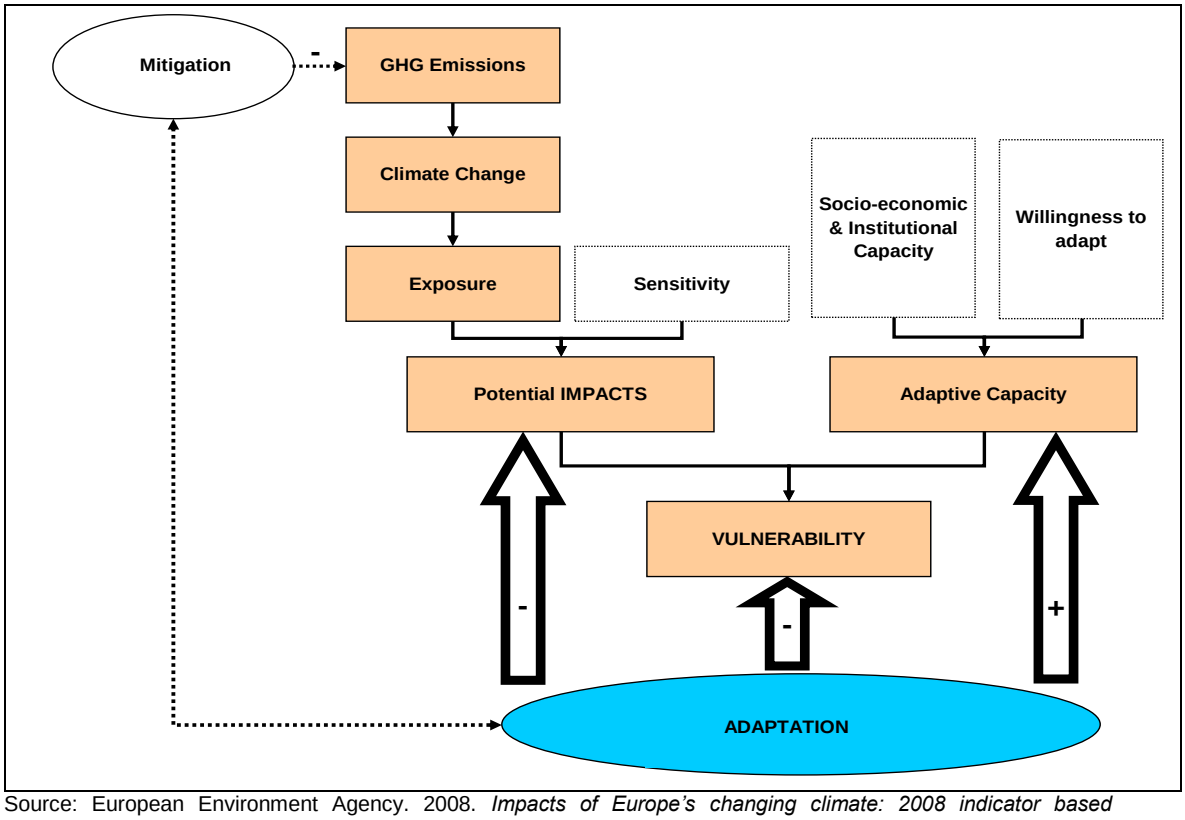
The aims of this workshop are:

- To provide an update on project progress, concepts and the key issues emerging to key stakeholders;
- To outline some examples of how vulnerability indicators could be developed to serve particular measurement purposes;
- To gain views about which option should be pursued as the 'test' or 'first' indicator and to identify other issues that should be considered in completing the project

3. What are the key concepts related to climate vulnerability?

The Impacts Assessment of the White Paper on Climate change identifies a number of potential impacts of climate change in Europe including: physical and meteorological impacts, impacts on biodiversity and ecosystems and their services and socio-economic impacts.

There are a number of conceptual and practical challenges in trying to assess the consequences of these potential impacts for natural or human systems. Climate change impacts are often seen as being a function of two factors: exposure and sensitivity. In conventional climate change terminology, *exposure* is the "nature and degree to which a system is exposed to significant climatic variations" (exposure to climate factors). *Sensitivity* is defined as the "degree to which a system is affected, either adversely or beneficially, by climate-related stimuli" (sensitivity to change). However, the concept of vulnerability goes one step further and includes a measure of potential capacity to respond: *adaptive capacity* is "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." (Definitions taken from the IPCC Third and Fourth assessment report). The relationship between these concepts has been depicted graphically.



Source: European Environment Agency. 2008. *Impacts of Europe's changing climate: 2008 indicator based assessment* (Ch.6. Adaptation to climate change; figure from Isoard, Grothmann and Zebisch (2008)).

Hence adaptation should *reduce* potential impacts, *reduce* vulnerability and *increase* adaptive capacity.

This definition of vulnerability is rather vague partly because it is based on other vaguely defined concepts (such as adaptive capacity). The terminology may hide a diversity of operational approaches that might still be consistent with the general definition used. Some of these issues will be discussed further in the workshop.

The ADAM project[3] looked at the way the term is defined and used across over 100 case studies from the climate change, disaster risk, poverty and food security literature. The main conclusion from this work is that the development of methodologies for assessing vulnerability can confidently disregard the purely theoretical debate on vulnerability, as it does not offer guidance on how to make the concept of vulnerability operational. Rather, methodologies for assessing vulnerability should be carefully developed in a 'bottom-up' way based on the specific research question addressed or policy objective and data available.

Similar conclusions emerge from other fields of study and sectors (such as sustainable development and ecological management) where the relationship between the concept and data is complex and potentially controversial.

What constitutes an appropriate method for assessing vulnerability will vary depending on the geographical, climatic, political and socio-economic context of the systems being assessed. Much of the existing literature on vulnerability comes from the human security and development community, where vulnerability can be characterized in terms of famine, conflict or the number of people killed, for example.

[3] See http://www.adamproject.eu/

In contrast, the European context of vulnerability might be characterized in terms of relative changes in health or ecosystem status. This therefore warrants a different selection of indicating variables.

4. How are vulnerability indicators defined?

Generally, indicators are used either to measure how one entity changes over time or to compare between different entities. This could be either to provide evidence that a certain state and/or condition exists, or to measure the degree of progress towards a target. One of the characteristics of indicators is that they should describe the state of complex systems in simple terms and hence indicators are primarily about communication. Ideally an indicator will bridge the divide between theoretical concepts and decision-making. Indicators should also fulfil a number of criteria once their purpose has been identified. These might include: credibility, legitimacy and relevance.

Developing a vulnerability indicator presents a further challenge. Since vulnerability relates to possible *future* harm, the indicator must try to measure a possibility, i.e. some thing that might or might not happen in the future. This forward-looking aspect of vulnerability indicators is often not made explicit in the literature and in fact many so-called vulnerability indicators are actually indicators of current harm rather than of possible future harm. This aspect of vulnerability indicators could be addressed in two ways: the indicating variables must either express a potential or a rate of change. Variables that express a potential are those that tell us something about the entity's ability or capacity to mitigate whatever harm it might face. The most prominent examples are GDP and other types of capitals (e.g., social capital). The literature on adaptive capacity focuses on these types of variables.

In practice, several different approaches are used to develop indicators and select the variables that constitute indicators, including subjective decision-making (e.g. through a stakeholder workshop), the use of existing scientific theory of evidence about the system of interest, and the use of statistical analysis to define relationships between particular observables and the aspect of vulnerability under consideration. There are advantages and disadvantages to all approaches, but for vulnerability indicators, the need for subjective decision-making at some stage is expected, given that the adaptive capacity component is open to multiple interpretations. In reality, variables are also frequently selected based on the availability of data. Some of these issues will be discussed further in the workshop.

5. What lessons can be learned from previous efforts to develop Vulnerability Indicators?

A limited number of studies have sought to develop indicators of vulnerability, or adaptive capacity, in relation to environmental and sometimes climate change. Details of three previous studies are outlined below to illustrate the diversity of the challenge.

The **ATEAM Adaptive Capacity Indicator** was developed by Schröter et al (2005)[4] as part of an EC-funded project into Advanced Terrestrial Ecosystem Analysis and Modelling. The indicator is intended to assess the adaptive capacity of economic sectors within Europe to global change (including climate change). The objective of the study was to assist policy makers with *a broad assessment of the vulnerability of human sectors relying on ecosystem services with respect to global change*. Adaptive capacity is projected for different timeslices (*1990, 2020, 2050, 2080*). The components of adaptive capacity used in the ATEAM indicator are: equality, knowledge, technology, infrastructure, flexibility, economic power. The variables used for each component were as follows:

Equality	female activity income inequality
Knowledge	literacy rates enrolment ratio
Technology	R&D expenditure no. of patents
Infrastructure	no. of tel. Lines no. of doctors
Flexibility	GDP per capita Age dependency
Economic power	world trade share budget surplus

The variables were selected by two routes: first, the IPCC third assessment report was used to compile a long list of components of adaptive capacity; second, a stakeholder-led process was used to identify the list of variables and the appropriate units for measuring variables, as well to decide thresholds outside which the adaptive capacity of the sectors is exceeded.

Because the objective of the study was a broad assessment of vulnerability, the accuracy achieved by this indicator is much less than would be required to, say, commit to allocation of funding for adaptation or evaluate the outcome of adaptation policy.

The **Climate Change Vulnerability Index** contained within the **Regions 2020** project was developed by the Commission (DG REGIO) in 2008 *to raise awareness among policy makers of the spatial distribution of vulnerability to climate change within Europe*. Vulnerability is projected for the year 2020 at sub-national regional level (mostly using NUTS-2 level data) to the stimulus of climate change. The conceptual components of the index are exposure, sensitivity and adaptive capacity, but due to data limitations and the specific scope of the project, the indicator is more a measure of exposure, and to some extent adaptive capacity, than sensitivity. The variables used to assess vulnerability are:

- Change in population affected by river floods
- Population in coastal areas below 5m
- Potential drought hazard (soil moisture)
- Change in GVA in agriculture, fisheries and tourism (based on temperature and precipitation changes)

These variables were selected based on available literature. However, the determining factor was data availability at sub-national regional scales. The selection

[4] Schro¨ter, D. Et al (2005). Ecosystem Service Supply and Human Vulnerability to Global Change in Europe. Science 310, 1333–1337.

process was therefore to a large extent decided during consultation with data providers (chiefly Eurostat and JRC), based on a high-level conceptualisation of vulnerability. Variables are assigned equal weights when aggregated into one final composite index.

The Regions 2020 project provides an effective tool to meet the objectives of raising awareness and describing the likely overview of the spatial distribution of vulnerability in Europe. Again, the results do not have the targeted accuracy to underpin specific policy decisions, such as in relation to funding for adaptation.

Brooks et al (2005)[5] developed the basis for an indicator of vulnerability to climate variability (and by extension, climate change) at the national level intended to provide global coverage of vulnerability (actually current harm, as the variables are not projected to indicate vulnerability to potential harm). The objective was to create a *national level indicator of vulnerability that can be used to inform policy* aimed at reducing vulnerability (adaptation). The variables are:

- population with access to sanitation
- literacy rate, 15-24 year olds,
- maternal mortality,
- literacy rate, over 15 years,
- calorific intake,
- voice and accountability,
- civil liberties,
- political rights,
- government effectiveness,
- literacy ratio (female to male)
- life expectancy at birth.

The choice of variables reflect the global scope of the indicator; many of the variables indicate impacts and conditions that are typically felt most acutely in developing countries such as maternal mortality, illiteracy, low life expectancy and restricted civil liberties. A long list of potential variables was drawn up using expert focus groups (normative reasoning). Subsequently, statistical analysis (inductive reasoning) was used to analyse the full list of variables to produce a short-list of 11 key variables.

Coming out of the examples above there are three observations. First, even though each study had an initial objective, none of these are specific in terms of the outcome desired from the use of the indicator, and consequently each indicator (or composite) provides only a broad measure that lacks the specificity or accuracy that would be needed to underpin more detailed policy decisions. Second, the interpretation of vulnerability and understanding of key components in the indicator is extremely varied: there is a wide range of variables included in the different approaches. Third, given the diversity of approaches and components suggested here, different vulnerability indicators could conceivably produce very different results or rankings of vulnerability.

The lesson from experience (as well as theory) seems to be that the more specific and targeted is the objective for the indicator, then the more accurate and useful is the indicator that is developed. Or the corollary: vulnerability indicators developed

[5] Brooks, N., Adger, W.N. and Kelly, P.M. 2005. Developing Indicators for Vulnerability and Adaptive Capacity at the national level and implications for adaptation. Global Environmental Change 15: 151–163

without a clear definition of their purpose can only provide information useful in the broadest sense.

6. What are the main purposes for EU vulnerability indicators?

An important first step in developing vulnerability indicators is therefore to establish clearly the specific purpose for the indicator. Guidance on indicator development suggests an important further preliminary step is developing a conceptual framework to clarify the nature and components of phenomena to be measured, and to help identify appropriate relevant variables. For complex issues such as vulnerability, where considerable uncertainties exist, the design of the framework will depend on the purpose of the indicators, the target user group (audience) and data availability. This framework should make the subsequent indicators easier to develop and ultimately to understand.

In the context of the White Paper, there could be multiple users of vulnerability indicators and a number of different purposes for their use. In this project, we make recourse to the over-riding principle that indicators must be 'fit-for-purpose', and look to identify the main possible purposes for vulnerability indicators in this context. The Impact Assessment to the White Paper on Adaptation sets out three operational objectives that need to be reflected in the subsequent action plan, and monitored moving forward:

a) Improve the knowledge base on climate change vulnerability (impacts and adaptive capacity) and on the costs and benefits of adaptation options;
b) Ensure early implementation of identified no regret and win-win measures and avoid mal-adaptation by mainstreaming adaptation in EU policies;
c) Put in place a process for a better co-ordination of adaptation policies and the assessment of next steps, including launching a debate for next multi-annual financial framework (p.26).

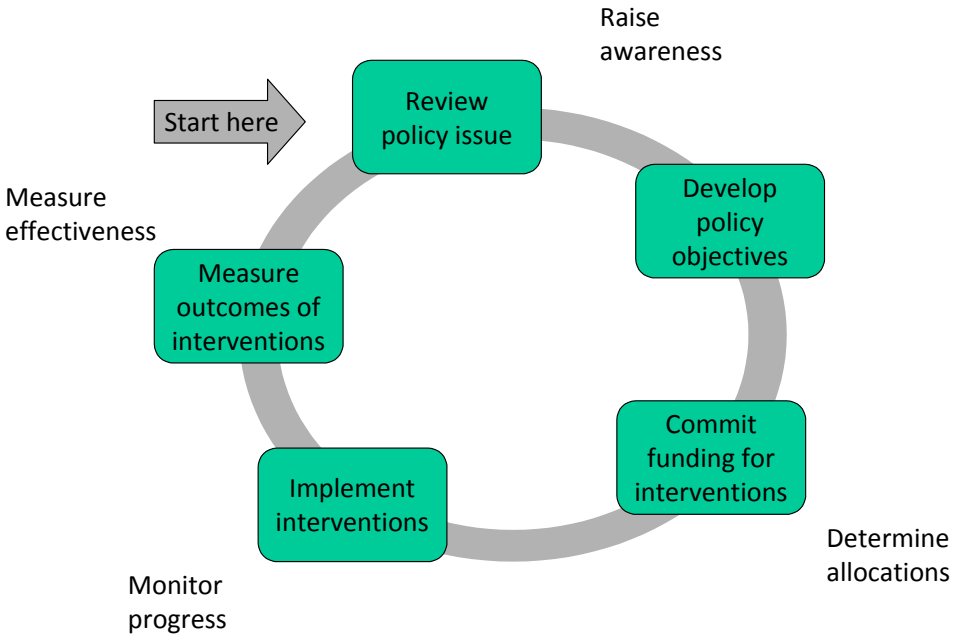
Additionally, the Impact Assessment accompanying the White Paper makes further specific reference[6] to building "a structured information dataset to better understand the territorial and sectoral distribution of vulnerability to climate change impacts", via a threefold approach which includes vulnerability assessment of the energy and transport networks overall EU, and regional vulnerability indices.

We have therefore identified 4 broad purposes, each associated with a different stage of the policy cycle, for which vulnerability indicators may be used:

- **Raising awareness of vulnerability to climate change impacts across the EU**, with a specific focus on regional vulnerability indices (although it is not clear which audience is primarily to be targeted for this raised awareness, nor what action or behaviour change is intended as a result);
- **Determining the allocation of EU funds for adaptation** (although it is not clear whether this focuses on funding specifically for adaptation projects, or on the integration of adaptation into existing funding streams);
- **Monitoring the progress of implementation of adaptation** (although it is not clear whether this is in relation to the implementation of adaptation at the EU level, or at any and all levels);

[6] See Action 1.2, page 126, Section 12.1 in the Impact Assessment

- **Measuring the effectiveness of adaptation interventions** (although it is not clear if this to evaluate the effectiveness of those interventions which fall solely within the EU level role, or to evaluate the effectiveness of all adaptation everywhere in Europe).



Each of these broad purposes requires further precise definition if indicators which are properly fit for purpose are to be developed. Clarifying the purpose and scope of the indicator could be done through a series of exploratory questions:

- What is the overall purpose of the indicator?
- What is the key policy objective and target which will be served by the use of the indicator?
- Who are the intended users?
- What is the scale of interest?
- What sectors / themes is the indicator to cover?
- What time frame is to be covered?
- Is the indicator to measure changes over time or to compare between different entities?
- What is the entity that is vulnerable?
- What is the stimulus to which it is vulnerable?
- What are the preference criteria to evaluate the outcome of the interaction between the entity and the stimulus?

The workshop will attempt to refine the purposes for EU vulnerability indicators, through the use of this set of questions, and illustrate the issues with particular sectoral examples. The workshop will also explore the options for developing indicators to meet these purposes.

7. How could vulnerability indicators be developed to meet these purposes?

Over the coming years an increase in the number and range of adaptation measures being implemented by stakeholders in many sectors and different levels of governance is anticipated. Ideally, these measures will all contribute to the reduction of vulnerability to climate change. However it is also possible that there may be knock-on effects and dis-benefits in terms of vulnerability either within the target sector or region, or in other areas. An ultimate goal for EU policy-makers would be a set of indicators that could both highlight the priority sectoral or regional vulnerabilities for attention in adaptation, AND assess the effectiveness of a wide diversity of planned adaptation measures. Additionally, such indicators would need to provide a consistent and comparable measure across different sectors and institutional levels, and for both centrally-managed programmes and co-funded initiatives.

These are extremely ambitious goals for vulnerability indicators, and the evidence from current and previous approaches is that experience within both academic and policy communities is not yet at a stage to provide such a "one-size-fits-all" set of indicators. Within this project, options for the development of indicators tied to more discrete policy goals are being pursued.

Raising awareness

Raising the awareness of decision-makers and those involved in policy formulation requires information to be presented in a different form from that required for members of the public. This might affect not only the presentation of the eventual results but also the process followed to develop the indicators. There is already a considerable body of information available which raises the issue of climate change impacts across Europe that provide a convincing argument for action.[7] The added value of vulnerability is it promises to provide a measure or indication of how an entity may respond to impacts. An inherent issue in developing indicators that provide a general measure of vulnerability in a simple, clear and hopefully unambiguous manner (in other words in a manner suitable for awareness raising) is that there will be numerous trade-offs. Some of these issues can be seen in discussions around the use of composite vulnerability indicators.

More targeted indicators that could be used to raise awareness of vulnerability should be impact, audience and sector specific; for example raising managers awareness about the vulnerability of southern European forests to increased seasonal risk of fire.

Funding adaptation

A pressing challenge for public decision-makers will be to determine how, where and in what form to intervene in the process of adaptation. An important aspect of this will be determining funding allocations, mainstreaming climate change concerns within policies that are being developed and also 'climate-proofing' existing strategies. Vulnerability indicators may help to understand what effect policies or programmes have on an entities ability and capacity to respond to projected impacts and potentially also help determine the most effective type of intervention by sector, region or against other criteria. This might primarily be tied to building the capacity to respond, such as through the operational programmes developed by Member states to meet the objectives of cohesion policy.

[7] Such as the EEA indicator based assessment : http://www.eea.europa.eu/publications/eea_report_2008_4

Monitoring implementation of measures

Monitoring the progress of adaptation will require a different set of indicators. Adaptation indicators for this purpose are currently being explored in the work of the EEA and will not be discussed further at the workshop.

Measuring effectiveness

Measuring the effectiveness of interventions is challenging as the majority of adaptation strategies (both geographical and sectorally based) are relatively undeveloped. So in many cases adaptation policies, plans and projects have not been in place long enough to assess how 'effective' they have been. Building capacity has been a focus of strategies and plans that have been developed however having the capacity to act is no guarantee of action. However based on the types of polices and strategies that are being implemented and put in place (in many cases impact specific) it is possible to explore the role vulnerability indicators could play in assessing the effectiveness of such policies.

For some very specific adaptation interventions, it may be possible to explore *ex ante* their potential effectiveness. However this is more likely to involve technical assessments of, for example, the way in which improved flood management measures might perform under different climate change scenarios, than the use of vulnerability indicators.

During the workshop, we will explore possible approaches to indicators for 3 of these purposes, making use of illustrative sectoral examples, as shown below.

Scope of assessment (based on threefold vulnerability assessment identified in White paper)	**Purpose of indicator assessment**			
	Raise awareness	Determining the allocation of EU funds for adaptation	Monitoring the progress of implementation of adaptation	Measuring the effectiveness of adaptation interventions
EU wide (cross-boundary) *[Case example: European energy infrastructure]*		**X**		
Sectoral (cross-region) *[Case example: Forest fires in southern Europe]*	**X**			
Regional (cross-sectoral) *[Case example: heat-wave action plans]*				**X**

8. A note on data requirements

In many cases, issues of data availability and quality will play the crucial role in determining what is possible in the short term (understood in this project as 2009 to 2013). It is important to distinguish between the results of studies, even those appearing in peer-reviewed academic literature, and true datasets which are consistent, comprehensive, robust and quality-assured. Much of the quantitative information available specifically for vulnerability has come from studies or projects, and is therefore not quality assured. The choice of variables for inclusion in indicators should ideally use true datasets rather than study results. For some sectors, appropriate datasets are extremely limited. This means that in selecting variables, recourse to more generic measures (such as economic, demographic or land-use metrics) may be needed, where sectorally specific datasets do not exist (such as populations at risk from particular hazards).

Vulnerability to climate change is about potential future harm and so requires the inclusion of both climatic and socio-economic projections, which have limited scope and coverage, and also inherent uncertainty.

This is a fast moving field and in the longer term there are numerous developments that will make it easier to develop indicators for particular purposes. This includes the development of a European Clearinghouse on Impacts and Adaptation, 7th Research Framework Programme projects and sectorally-based data collection and monitoring initiatives.

9. Key questions for participants

These questions are to help stimulate discussion at the workshop

- How have you taken (are you taking) decisions about adaptation? What sources of information have you used (are you using) to inform those decisions?

- The project has identified four broad objectives (or purposes) that vulnerability indicators could serve. Are there any other needs which could be served by properly targeted vulnerability indicators?

- What specific questions would you like a vulnerability indicator system to answer?

- Are there alternative tools or methods that you are using, or aware of, that could fulfil the role envisaged for vulnerability indicators in this project?

- The focus of the project to date has been on the policy context established by the White Paper. However, many levels of governance, and a wide range of sectors, need to work together to achieve adaptation outcomes across the EU. How could a consistent set of indicators, as envisaged here, be useful to your own work?