Putting climate change adaptation into action: an operational approach to implement the European Guidelines on developing adaptation strategies

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Abstract

The European Commission recently released the Communication "An EU Strategy on adaptation to climate change" (COM(2013) 216 final) and a series of related documents, including the Guidelines on developing adaptation strategies (SWD(2013) 134 final). In parallel to those documents, a significant effort is ongoing at the EU level through the European Environmental Agency (EEA) and the European Topic Centre for Climate Change adaptation (ETC-CCA) for the development of the European Climate Adaptation Platform (Climate-ADAPT) as the 'one-stop shop' for adaptation information in Europe, including the Adaptation Support Tool, coherent with the contents of the Guidelines, and intended to move further towards supporting Member States in operational implementations. This paper shows how a pre-existing methodological framework and suite of tools for supporting participatory decision processes can be easily adapted to provide the operational solutions to the principles enunciated in the EU Strategy and the prescriptions of the related Guidelines.

Keywords: Climate change adaptation strategies, assessment, decision making process

1. GUIDING AND SUPPORTING THE IMPLEMENTATION OF CLIMATE CHANGE ADAPTATION (CCA) STRATEGIES IN EUROPE

The European Commission has recently released the Communication "An EU Strategy on adaptation to climate change" (COM(2013) 216 final) and a series of related documents, including the Guidelines on developing adaptation strategies (SWD(2013) 134 final). The EU Strategy calls Member States (MSs) for remarkable efforts in terms of developing new adaptation instruments (National Adaptation Strategies and Plans) and revising those already produced. The Guidelines are aimed to contribute to achieving the objectives of the EU Adaptation Strategy, and in particular promoting action on CCA by MSs, but also contributing to climate-proofing actions and increasing resilience in Europe through CCA efforts in key sectors (agriculture, fisheries, etc.), and facilitating the implementation of better informed decision-making by addressing gaps in knowledge. In parallel to the documents mentioned above, a significant effort is in place at the EU level through the European Environmental Agency (EEA) and the European Topic Centre for Climate Change adaptation (ETC-CCA) for the development of the European climate adaptation platform (Climate-ADAPT) as the "one-stop shop" for adaptation information in Europe, including the "Adaptation Support Tool", coherent with the contents of the Guidelines, and intended to move further towards supporting MSs in operational implementations. The cyclic flow-chart depicted in Fig. 1 reports the six steps foreseen for the implementation CCA strategies in Europe.

Over the last two decades, a series of research projects under my scientific responsibility brought to the developments of a methodological framework called NetSyMod (Network Analysis – Creative System Modelling – Decision Support), aimed at providing a flexible but comprehensive and operational contribution to decision support through a suite of methods and tools for facilitating participatory decision making processes (DMPs) dealing with socio-ecosystems, including CCA. Decision is here intended in a broad sense, including any process in which a choice has to be taken by examining the available information on a given problem. The problem itself, the information, and the choice are defined with the contribution of different actors. The implementation field of NetSyMod is in general the management of natural resources, with two typical application cases, which may be also encountered together in the same case, depending on institutional and legislative contexts: (i) the involvement of experts in a decision or an evaluation of an environmental problem requiring multiple fields of expertise, and (ii) the involvement of interested actors in a participatory process dealing with the management of environmental resources.

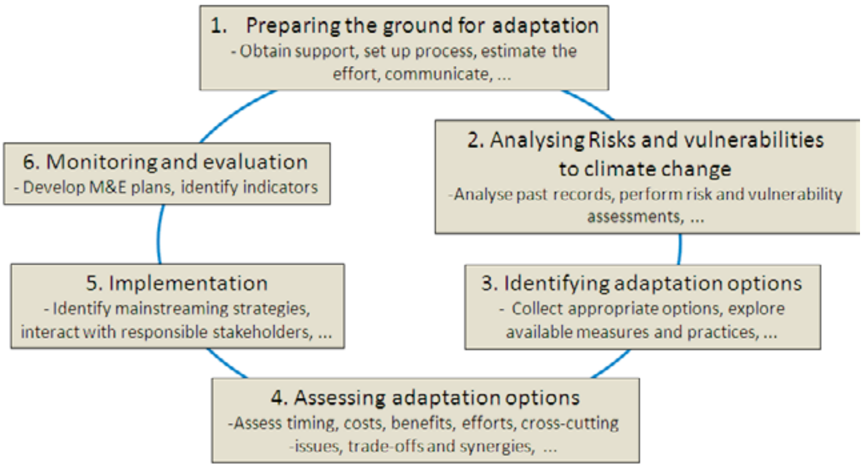

Fig. 1: The sequence of steps for the implementation of climate change adaptation strategies proposed by the EU Guidelines (SWD(2013) 134 final**) and the Adaptation Support Tool (**http://climate-adapt.eea.europa.eu/en/web/guest/adaptation-support-tool/step-1**).**

The proposed approach is aimed in particular at facilitating the integration of environmental, social and economic knowledge and the involvement of interested parties in the formulation of strategies and decisions. This appears to be perfectly in line with the EU approach for the identification and implementation of CCA strategies, typically characterised by choices to be made between alternative plausible options (strategies and measures) with the involvement of multiple actors. As the EU Guidelines, the NetSyMoD approach foresees the implementation of a cyclic sequence steps (see Fig. 2), which are in general consistent with those proposed by the EU documents cited above. The similarities between the two approaches are evident from the comparison of Fig. 1 and 2: step 1 is in both cases focused on setting up the process and defining the problem, thus providing the ground for adaptation. NetSyMoD emphasises more the need for an effective participatory approach since the early stages of the process and thus its step 2 is specifically focused on the identification of the main actors to be involved (experts, policy makers, and stakeholders in general) and the design of scientifically sound and robust participatory activities. Step 2 in the Adaptation Tool and in the Guidelines corresponds to the third one in NetSyMoD, and they are focused on the analysis of the problem, i.e. the assessment of risks and vulnerabilities to climate change. The outcomes of those steps allow for the identification of the adaptation options (Step 3 of the Guidelines) and their description, with the support of various data processing, modelling and preliminary evaluations as proposed in Step 4 of NetSyMoD. In parallel, the assessment of adaptation options is approached in NetSyMoD through the "Analysis of Response Options". Finally, steps 5 and 6 of the Guidelines are approached in NetSyMoD through the sixth step, which includes both action taking (Implementation) and Monitoring of the effects of the strategies adopted. NetSyMoD is presented in more details in the two following sections, with focus on steps 3 to 5.

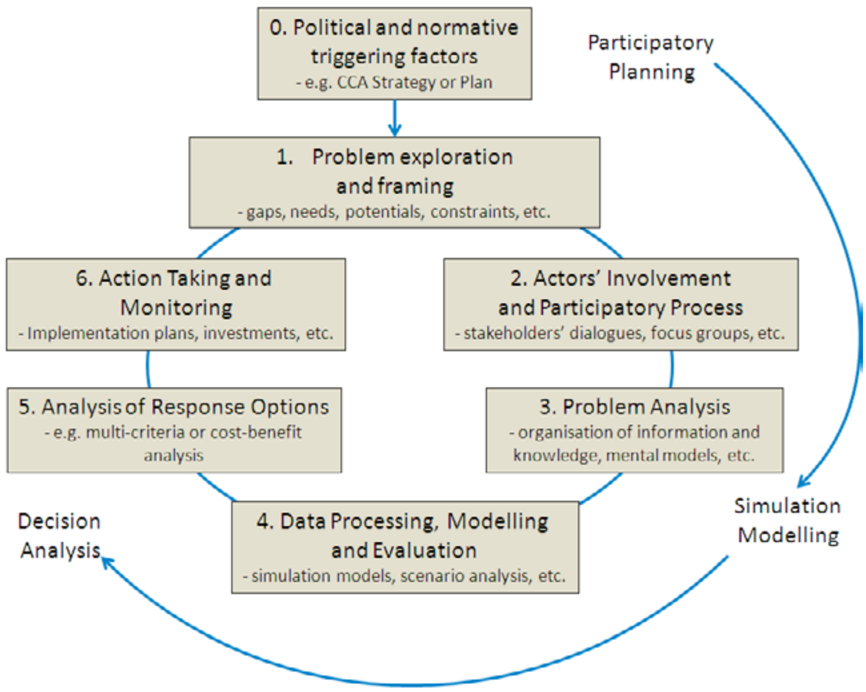

Fig. 2: The sequence of steps for the implementation of climate change adaptation strategies proposed by the NetSyMoD approach.

2. PROBLEM ANALYSIS AND DATA PROCESSING, MODELLING AND EVALUATION

As depicted in Figure 2, we propose two initial steps in which a substantial role is played by participatory approaches: problems and decision are first explored in the Problem Exploration and Framing Phase and then the participatory activities are designed and launched in the Actors'

Involvement and Participatory Process Phase. Having identified the decision context (i.e. the specific CCA case), the actors to be involved and how to deal with such issues, ideas are further elaborated and formalised in dedicated workshop activities, which facilitate collective learning and the building of a shared conceptual model. The latter - usually developed trough Cognitive Maps, Causal Loop Diagrams or similar - provides the common communication basis, together with the frame for the design of data processing, modelling and evaluation procedures. As proposed in NetSyMoD, these initial steps are also intended to provide solid bases for the development of a dedicated Decision Support System (DSS). The DSS here plays a fundamental role as a means to facilitating the integration of scientific knowledge and participatory approaches, and for providing end users with efficient methods and tools for the management of the process leading to the implementation of CCA measures.

A few very important rules for effective DSS design can be extracted from Giupponi et al. [1]: (i) adapt existing or new DSS tools to the needs and not vice-versa; (ii) refine mutual understanding of users' requirements throughout the development phase and ensure flexibility; and (iii) develop effective analytical tools for the assessment of uncertainty and interfaces for its effective communication.

The main outcomes of the Problem Exploration and Framing Phase are the identification of the most relevant aspects of the decision, including legal and institutional ones, and, in particular:

- a list of most relevant exogenous and endogenous drivers governing the system and the problem considered;
- a preliminary list of options to be assessed (i.e. plausible approaches for adaptation);
- a preliminary set of scenarios regarding the future development of the main drivers and cause-effect relations;
- a list of decision criteria and possibly quantitative indicators against which the performance of the possible solutions (alternative options) can be measured.

The degree of, and the approach for, actors' involvement should be defined case by case. We propose the organisation of one or two workshops, depending on the number of issue to discuss (e.g. needs for future scenarios; potentials for quantitative assessment to follow a preliminary qualitative analysis), the complexity and uncertainty of the problem, and the number of stakeholders to be involved and their availability. In order to minimise the time required for the preparation and briefing of participants, the questionnaires used for stakeholders' analyses in the initial phases can also be used to collect their views and opinion on one or several of the information typologies listed above. This is to facilitate the participation of key stakeholders by limiting the duration of workshops that should be possibly organised to last less than one day. These workshops aimed at problem analysis and development of shared cognitive models of the problems at stake are called Creative System Modelling (CSM) Workshops. By CSM workshops we intend a form of participatory modelling in which cognitive mapping techniques are used to design and later on develop a formal dynamic model aimed at the analysis of the of the socio-ecosystem considered in the specific case, with the contribution of the involved actors. CSM provides not only a common ground for the mutual understanding among the parties involved, but also a sound basis for the development or tailoring of the DSS tool and for easier communication with the general public.

A revised version of the DPSIR framework (Driving Forces, Pressures, State, Impacts, Responses; proposed by [2]) is the preferred reference for building a shared model of the adaptation problem at hand, by formalising the relevant cause-effects chains within a conceptual model based upon an easily understandable language. Such a scheme, proposes an extremely simplified causal model of a social-ecological system and, in particular of the relationships between human activities as Driving forces, exerting Pressures on the State of the environment, which in turns may result in Impacts requiring interventions by policy/decision makers (Responses) – in this case adaptation strategies and measures. In order to make it more suitable for dealing with climate change purposes, we have further developed the DPSIR framework into DPSIRS by including a new category of elements (Exogenous Drivers), to represent all the forcing variables acting from outside the system boundaries (climate change phenomena, higher level policies, international agreements, etc.), which should be considered when analysing alternative Scenarios, as it should in the assessment of CCA options.

In order to build a shared causal model of a given problem through a participatory process, by exploring viewpoints, beliefs, values, and knowledge, several approaches are available. The cognitive mapping (CM) approach is our preferred option [3], since it emphasises surfacing deeply held beliefs in form of mental models, which can be easily communicated with simplified symbolic languages, such as the DPSIRS framework. Very importantly, CM can also provide an effective basis for further developments towards simulation modelling. Our preferred sequence is to make the CM evolve into Causal Loop Diagrams, and further into Stock&Flow Relational Diagrams with a final formalisation step by means of system dynamic modelling tools in order to develop the system of differential equations required for the modelling needs. Loos of full coupling of modelling outcomes are then implemented within the DSS tool.

Exploration of plausible future scenarios, on the basis of previously developed reference storylines (e.g. the SRES scenarios developed by the Intergovernmental Panel for Climate Change at the global level; [4]) is also of great potential in these phases, because it allows for defining possible boundary conditions which could determine the effectiveness and the robustness of current decisions.

The Data Processing, Modelling and Evaluation Phase builds upon the knowledge developed in the CSM workshop. The identified cause-effect relations and the screening of adaptation options, scenarios and indicators helps to articulate questions the simulation models have to answer. Very importantly in this phase all the decisional criteria to be considered are identified, thus indentifying also the information needs and the elaboration procedures to be implemented in the DSS.

3. ANALYSIS OF ALTERNATIVE RESPONSE OPTIONS

The analysis of alternative options is carried out during an ad hoc workshop, which could be merged with the CSM one, in particular in those case in which the assessment of options is carried out by means of qualitative assessment provided by the stakeholders/experts involved in the CSM. Otherwise, the ideal situation is that a quantitative assessment follows the preliminary qualitative analyses, once the quantitative results are available to provide an assessment of the expected performances of the alternative response options, usually through model simulations.

An original piece of software developed throughout a sequence of research grants, mDSS (from MULINO-DSS) is usually adopted in NetSyMoD applications to manage the crucial steps of the assessment of alternative options, from the formalisation of the problem at hand within the DPSIRS framework, to the analysis of multidisciplinary outcomes by means of Multi-Criteria Decision Methods (MCDMs).

Typically, an Analysis Matrix (AM) is built by processing qualitative and/or quantitative data (spatio-temporal indicators) representing the performances of the alternative options (e.g. alternative option, strategies, or projects) according to the selected criteria. The AM thus stores the performances of the alternative options, evaluated individually against each decision criterion. In some cases some of the criteria cannot be assessed by means of quantitative indicators provided by model simulations, and thus actors can be asked to provide their own qualitative evaluations, and their preferences are integrated with the quantitative indicators in order to complete the filling of the AM.

At this stage MCDMs provide a framework for decision analysis, and a set of techniques aiming at the elicitation and aggregation of decision preferences [5]. Preference analysed by MCDM can be imagined as a choice or ranking of alternative options assessed through their performaces according to a series of criteria [6]. All multi-criteria decision rules aggregate partial preferences describing individual criteria into a global preference index/score and rank the alternatives. Examples of techniques implemented in the mDSS software[1] are (i) Simple Additive Weighting (SAW); (ii) Order Weighting Average (OWA) [7]; (iii) the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [8]; and (v) ELECTRE [9, 10, 11, 12, 13]. In addition, several techniques for elicitation of weights are available such as pair-wise comparison, swing weighting, direct rating and hierarchical weighting. Moreover, as far as the DSS considers – as it should – the subjective preferences of the involved actors, their different views and preferences (e.g. through the expression of different weighting), divergences are to be expected after the problem analysis, and thus also conflict mitigation/resolution must be performed. This can be implemented in different ways such as using inter-personal preference aggregation, or, simply, by performing parallel evaluation procedures to assess whether or not the diversity of opinions would lead to different results in terms of suggested choice, i.e. ranking of alternatives.

The results of the assessment of adaptation options should be adequately documented, and assumptions, subjective choices and uncertainties of various kinds should be transparently communicated with charts, tables, and statistical annexes. Such documentation should allow interested people to go step-by-step deeply in the understanding of all the details of the decision process. On the other hand, also effective concise means should be adopted for communicating the results to a brad public. An example being the interpretation of results in terms of sustainability of the decision, expressed in terms of balanced environmental, economic, social and institutional performances of the options analysed. Following the MCA approach proposed above, criteria can be allocated to the pillars of sustainable development, and effective graphical means can be used to explore their balancing in a chart in which the various options are allocate in a space (see Fig. 3 for examples of sensitivity and sustainability of decisions).

[1] www.netsymod.eu/mDSS/

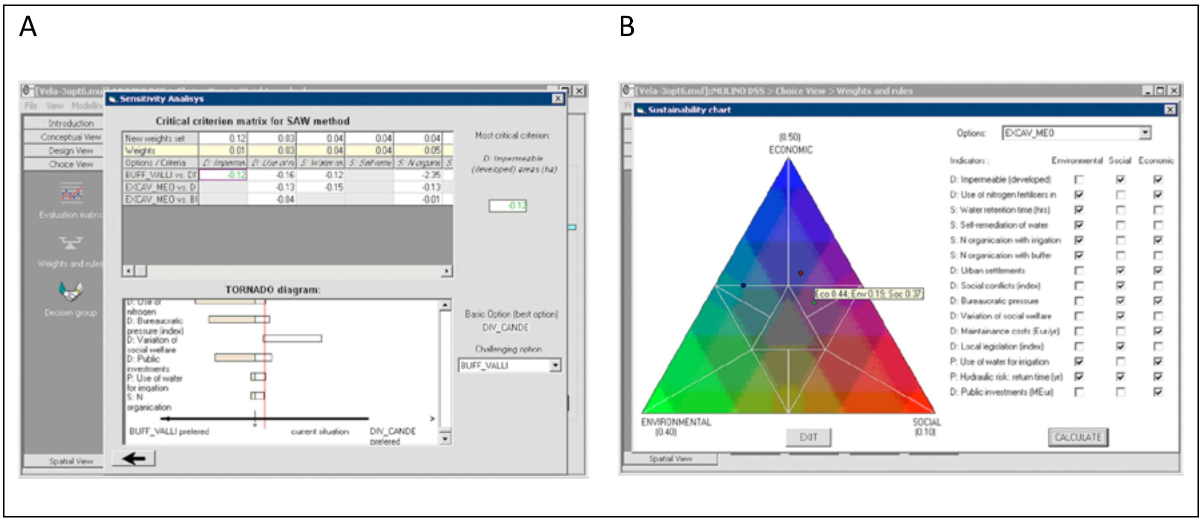

Fig. 3: Sensitivity analysis (a) and sustainability chart with performances of the preferred options (b) (from [14]).

In Practice, depending on the resources available, the relevance of the problem to be analysed, the availability of information, etc. two main application context can be foreseen: (i) qualitative analyses based only on expert judgement, or (ii) quantitative analyses carried out making use of simulation routines to estimate the expected performances of the proposed options, for each selected criterion/indicator. Case (ii) typically follows (i), and in that case a first exploratory and qualitative workshop is followed by the Data processing Modelling and Elaboration phase, which produces the outputs to be presented at a second workshop.

4. CONCLUDING REMARK

The European Commission has recently released a comprehensive set of policy documents which will guide Member States in the process of implementing or revising climate change adaptation strategies. Operational solutions are needed in particular in those countries such as Italy, where the process of developing national and local strategies for CCA has only recently started. The NetSyMoD approach, already tested in various CCA contexts, can be one of them. The development of the Italian National Adaptation Strategy and Plan can be an opportunity for capitalising the experiences developed over two decades of research projects in the field of decision support and made available though a coordinated package of methods, tools guidelines and tutorial documentation. It could also be an important opportunity to go beyond state of the art of the approaches adopted elsewhere. At this regard, at least two directions emerge as of particular interest for research developments:

1) integration of methods and space and temporal scales between disciplines and between the science and policy spheres;

2) management of the various sources of uncertainty intrinsically inherent in decision processes such as those related to sustainability and climate change adaptation, in which decisions are to be taken today in consideration of the current – limited – understanding of the evolving dynamics of social and ecological systems.

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