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A note on attitudes towards and expectation from the Decision Support Systems

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Abstract: For long time Decision Support Systems (DSS) have been believed convenient tools for transferring scientific knowledge, ready-to-use and free of political interference, onto policy-making agendas. The concept seemed to appeal to scientists and policy makers alike. The former embraced DSS as a way to get their voice heard, the later were believed to benefit from the easy-to-use interface to intricate models. The enthusiasm had not been shared by all scientists. Many complained about the limited uptake of the tools and their conditional suitability to address practical policy issues, messy and intractable as they often are. Different reasons were suspected for this drawback. In this paper we look into different pieces of evidence to find out what scientists, policy makers and users think of DSS, their limitation and hurdles which need to be overcome to put DSS at work. These sources include results of expert workshop, e-surveys targeted to DSS developers and users, interviews with scientific officers from the funding agencies, review of the EU FP Working Programmes and the databases of funded projects, and review of the scientific papers dealing with DSS.

Keywords: DSS; users' acceptance; implementation gap

1. INTRODUCTION

Assessing the extent to which diverse Decision Support System (DSS) lived up to the initial promises is a daunting task: many tools with little in common are referred to as DSS; there is little agreement on what constitutes the success or failure; and the importance of factors behind the success varies greatly from situation to situation.

Yet despite all these difficulties, it is important to study why and how decision support tools are used (or not used), by whom and for what purpose. Insights from these studies can help to assess the impacts and benefits to improved decision making, avoid mistakes and frustration, and restore reasonable expectations from scientists, scientific officers and policy makers.

In this paper we make sense of evidence from different sources, including results of an expert workshop, surveys targeted to DSS developers and users, in-dept interviews with scientific officers at the DG Research and the DG Environment, literature review and e-mails communication with users and developers. These sources are described in the annex. Our analysis is restricted to the DSS developed or used for water management. These systems typically integrate advanced modelling, simulation, optimization and knowledge-based tools with spatial data management functionality.

2. IN SEARCH OF DSS IDENTITY

There are many competing understandings of what DSS are or how they assist decision making. In Giupponi et al. (2007) we have explored this variety of meanings, suggesting that the common understanding is not strictly related to any of the proposed definitions. When asked to describe the tools in their own words, the DSS developers referred to expert involvement, supplementary techniques not translated into software code, tips and rules, and process management, in addition to different kinds of computerised tools.

The DSS occupy a niche at the border between science and policy; this niche is characterised by employing diverse software technology to support decision making. It is convenient to conceive DSS as a software instrument to transfer scientific knowledge, ready-to-use and unspoiled by political interference, onto policy-making agendas. The idea to wrap up up-to-date knowledge so that the complexity remains hidden appealed to scientists and policy makers alike. The former embraced DSS as a way to get their voice heard, the later were believed to benefit from the easy-to-use interface to intricate models.

However, there are several problems with this ambition: First, to justify efforts and means put into software development, the final product needs to be flexible enough to be applicable in a range of situations. This is at odds with traditional scope of DSS to address ill-defined problems which are hard to penetrate, complex to tackle and to a large extent unique [Cox, 1996]. Second, DSS as a nutshell of knowledge can work out only if the knowledge is well established and represent consensus among scientists. Not-yet-established knowledge, rife with uncertainty and thus contentious, although potentially indispensable for making sense of a policy situations, is not consistent with notion of credible software tools.

The issues of deep and unreducible (at least in short term) uncertainty and risk, along with role and accountability of scientists in situations in which these issues substantially affect policy making are at centrestage of science-policy dialog. Back in 1972, Alvin Weinberg called "trans-science" an area in which the essential issues seem to be resolvable by impartial knowledge, but which science for different reasons cannot unambiguously answer [Weinberg, 1972]. His and others' contributions fuelled a debate about the professional responsibility of scientists advising or taking part in policy debates for which they claim special expertise. That debate compelled the Operation Research Society of America to issue "Guidelines for the Practice of Operational Research" [Machol, 1972], suggesting ways how to reconcile scientific norms with adversary policy practices. More recently, similar debate had been held in environmental modelling disciplines, prompted by constructive critique of how mathematical simulation models were used to inform practical policy making [Edwards, 1996; Konikow and Bredehoeft, 1992; Oreskes et al., 1994; Pielke, 2003]. This debates prompted development of best practice guidance and help to sensitise modellers to issues and requirements of policy making.

Remarkably, these topics haven't been echoed in the DSS field, mostly concerned with usability of software and interfaces practical to conceal the complexity of scientific matter. The key topics discussed at the mainstream of the DSS field, although valuable for developing decision tools useful for practical purposes, featured dominantly software aspects and responsibility of scientists as tool developer, but not as scientific adviser. The major DSS topics include advanced software development methodologies, flexible enough to allow the intended users to constantly refine their requirements; assessment of usefulness and usability of the decision tools; critical success factors driving the diffusion and uptake of the tools for practical policy making; and advanced techniques for problem structuring and decision analysis, supporting different decision modes and styles.

To wrap up, many have tried to explain what the DSS are by listing what these tools should contain, or how they should inform the decision processes. We believe that the topics neglected in the DSS field but found important in other fields of science-policy interface are equally useful to explain the DSS and why they haven't been found easy to implement.

3. FUNDING OPPORTUNITIES

The past EU Framework Programmes (FP) funded many research projects which placed the DSS development prominently in their intents. But it wasn't until the FP5 (1998 - 2002) that the number of these projects reached a level never seen before. The FP5 Programme Energy, Environment and Sustainable Development (EESD) dedicated one of the six key actions to management and quality of water, under which the DSS development was explicitly encouraged. At that time the EU Water Framework Directive was yet to be adopted and the DSS were deemed useful tools to assist the water managers with the new requirements. Compared to three DSS projects funded under the FP4 (1994-1998), the FP5 supported twenty research projects explicitly meant to develop a DSS for practical water resource management. In the FP6 (2002 - 2006) the excitement dwindled away and applicants stopped placing the DSS as their foremost priorities. The funding instruments (integrated projects and networks of excellence) introduced in the FP6 encouraged large consortia and more ambitious objectives, making the decision support tools to take a back seat. Only four smaller projects (specific targeted research project STREP) placed the DSS more prominently.

The FP7 Working Programme 2007 mentioned DSS only once, asking for "decision support systems ... to allow stakeholders and decision makers to meet the often contradictory challenge of integrated resource planning without compromising natural resources of future generations (p. 31, FP7 ENV 2007). More generic terms such as decision support tools and decision support are mentioned a few more times, linking these tools to scenarios development, and prediction and adaptation to (expected) climate change impacts. The FP7 (2007 - 2013) puts emphasis on climate change research and impact assessment, i.e. topics which require examination of diverse bodies of knowledge which are rife with fundamental uncertainty and thus potentially contentious. Risk and hazard assessment, along with uncertainty analysis took the place once occupied by the decision support.

As the research priorities changed with time, so did the funding instruments and the research approach deemed most suitable. Along with these changes the FP7 encouraged engagement of civil society organisations (CSO) in research projects, creating so more and better opportunities to engage in a mutually beneficial dialog with scientists. The funding scheme "Research for the benefit of civil society organisations" introduces new participation modes and methods with higher potential in term of mobilisation and opening space for expressions. The projects funded under this scheme are composed by research organisations (RTD) and CSO who are who are equally involved in design, management and implementation of the research activities and their quality assurance.

The interviews with the scientific officers from the DG Environment and the DG Research shed light on the perceptions behind these changes. Operating at the science-policy interface, the interviewees appreciated the complexity of policy making processes more than scientists and DSS developers did. Because of this complexity, the DSS are believed more useful at lower (regional or local) levels of policy making, where the decisions are driven by technical considerations, rather then by political differences and positions. The appeal of DSS is related to the introduction of a coherent methodology and assessment techniques which yield comparable results across different regions. Many interconnected tools are preferred to monolithic, one-size-fits-all systems. The practical tools are expected to instigate dialog between the policy actor, to "simplify problems" and to test policy options. The tools' credibility is established by their transparency and ability to commence agreement and shared understanding. The low uptake of DSS and scientific advices is attributed to different cultures in science and politics/policy making. Any improvement would require greater scientific proficiency among policy makers and more openness to scientific information. The scientists are requested to better appreciate policy needs and tailor the scientific presentation for specific policy purposes. Most importantly, the scientists need to demonstrate suitability of scientific tools for any given policy requirement. Often, this demonstration is not sufficient and scientists are seen reluctant to engage in dialog with policy makers.

4. DSS DEVELOPERS PERSPECTIVE

Most of the approached developers appeared satisfied with their DSS related research and were not concerned about the fading prospects of DSS field. In contrary, most of the respondents were determined to do more research on the topic.

The respondents were convinced that existing DSS improved the communication between policy makers and scientists. The tools were also granted the ability to explore the issue from various standpoints, a feature which nearly everyone agreed is a defining attribute of DSS. But the respondent disagreed on whether these accomplishments are sufficient to improve decision making and to reconcile conflicts between the different legitimate views on what constitutes the problems and how it should be tackled.

The respondents apparently knew of or were actively involved in different cases in which DSS were applied successfully, and in others in which the DSS failed to meet the requirements of the intended users. The DSS failure were not necessary due to limited value of scientific knowledge to resolve policy issues, even if the most respondents acknowledged that the intricacy of policy processes were often neglected in scientific studies. Still, the respondents challenged the notion that the developed DSS remained mainly academic exercises with little impact on practical policy making.

Despite the mixed experiences, many respondents strongly believed that the academic research projects brought significant innovation and produced a host of benefits other than the software. Likewise, not all respondents believed that the implementation gap will diminish with greater IT proficiency of the policy makers or with technology advancement. Important achievements included assistance in problem exploring and facilitated exploration of different perspectives. On the other hand the past experiences of many have suggested that the DSS related efforts were not particularly useful to instigate interdisciplinary research.

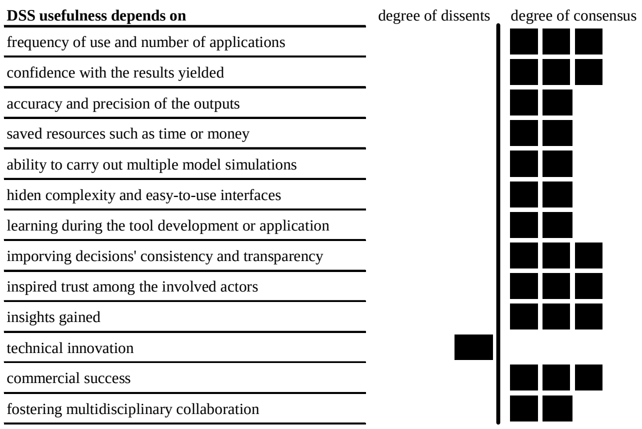

Figure 1. Respondents' perceptions of what constitutes success of DSS.

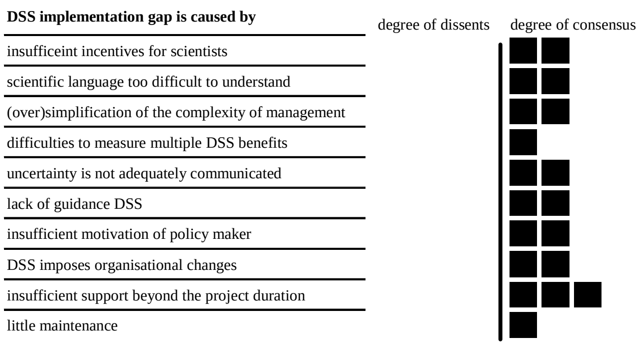

Figure 2. Reasons held responsible for low uptake of the

Among the various DSS components, the data management, visualisation, model integration framework, algorithms to deal with qualitative data and uncertainty, as well as multicriteria assessment models received unambiguous support (see figure 1). The perceptions of other components' importance varied greatly among the respondents. Economic assessment techniques (e.g. cost benefit analysis), economic impact models and tools facilitating online discussion were encountered with strongest hesitation. Despite the fact that uncertainty analysis is ranked upon the most important components of DSS, the prevailing perception is that this topic is somehow neglected in practical applications.

Many factors have been found important for explaining the low uptake of existing tool for practical policy making (see figure 2). Among them, the quality of the developed tools divided the respondents, a fact which can perhaps be explained by different standards of quality and success. The academic institutional barriers and insufficient support beyond the project duration were among the factors which most respondents agreed on.

In their future research, most responders intended to address the implementation gap by paying attention to more user-friendly interface and by a closer collaboration with the end users. Only a few found it important to investigate the other barriers for limited diffusion of the available tools. The further progress in the field has however, not been linked to technology advances or increasing IT literacy among policy makers.

When reporting the achievement of DSS related projects, many scientists provided none or only constructed example. The paper which included description of real policy applications did not provide sufficient detail for an independent review and quality assessment. Stakeholder engagement was omitted completely or attached little importance. The evaluation of developed tools was hardly reported and only few articles included recommendations about what should be done to increase the uptake of the DSS.

5. USER PERSPECTIVE

Consistent with the expectations, our survey revealed a great variety of the DSS users and intermediaries. Among the users who responded to our survey were many agency scientists and scientific advisors with background in natural science. The other largest groups consisted of senior officials and high-level directors. Although most of them did not have prior experience with DSS, two quarters of the respondents interacted directly with the tools installed on their personal computers.

Their role in DSS application included most frequently the specification of the requirements, only half of the respondents were subsequently involved in the tools' practical application. Implicit expectation from many respondents was that DSS would facilitate stakeholders' engagement and help to identify policy options relevant for the given situations. Justifying decision taken in advance and satisfying regulatory obligations ranked fairly high. However, in the most cases the DSS application was an exercise or an exploratory study proposed by the academic partner. Less frequently, the efforts associated with the DSS development were justified by the new policy requirements and the limited skills of the previously used tools to support increasingly complex decisions. This explains the fact that the DSS, although dully maintained in the users' institutions, was used only in a few cases, often just in a single situation.

Contrary to what DSS developers believed, the users appeared convinced that the DSS improved the decision making compared to the approach which would have been applied otherwise. In a few cases the DSS were contested by those who were affected or involved in the decision. The satisfaction with different components of the systems appeared well balanced.

6. CONCLUSIONS

In this paper we have tried to combine diverse evidence to make sense of scientists' and users' opinions on DSS and motivations for their uptake or lack of thereof. More often then not the would-be-users were attracted into DSS projects by curiosity and interests to experiment new policy analysis tools. If the initial interests grew into durable commitment than the objective has been met. If this did not happen, for many possible reasons, than the exercise may still not have been useless.

While encouraging the DSS development, the research agencies intended to create institutional conditions for a greater engagement of scientists and policy makers in a mutually beneficial dialog. The decision tools had not been specified in detail in call for proposals, allowing the developers to design the content creatively. As the research priorities shifted to areas where the knowledge is provisional and constantly evolving, as it is the case of climate change impact assessment, software tools appears less attractive as the instrument of knowledge transfer. The engagement of policy makers and wider stakeholders in designing research activities is, however, more imperative than anytime before. So is the scientists' contribution to policy debates, despite or perhaps because of the scientific uncertainty which underpins these debates.

The practical policy application of the developed DSS became unwritten demand and a way of practical corroboration of the developed tools. This is not wrong if the scientific articles provide sufficient detail for other scientists to review and assess the quality of the scientific advice given. Many reports however don't provide this detail. Innovation at the science-policy interface can have different forms: It can relate to improved content of the tools, their adaptation for specific purpose or study area, or their integration with other tools or modes of knowing. Alternatively, it can refer to how the tools have been used to inform policy making, how they facilitated dialog between the policy actors and how robust and lasting had been the agreement or consensus achieved. The latter requires new ways of engagement of scientists and policy makers/stakeholders, which is not possible without a greater understanding and appreciation of the policy process by scientists.

To facilitate these positive developments, we include a few recommendations that arose from the material analysed in this paper[1].

1) To facilitate independent review and reuse of tools developed; the scientists should cooperate more closely with open source software community. Software developed thanks to public research funds should be accessible for free and dully documented. Similar requests had been advanced by funding agencies (e.g. US National Health Institute) for scientific publications.

2) A repository of the software can help to keep track of the tools' further development and to facilitate experience sharing among users and developers.

3) Greater differentiation of funding opportunities and more incentives for greater involvement of stakeholders in planning and implementation of research activities. The new FP7 instruments (such as research for the benefits of civil society organisations) are a good example.

4) Better documentation of the results, including the stakeholder processes applied, and the critical scrutiny of the results yielded. The scientific community engaged in the development of decision tools should develop their own best practices and code of conduct in a similar way as this has been done in other policy oriented fields.

ANNEX: Sources on which the paper bases

1) A two-day expert workshop organised in Venice, October 2005 to review the experience from the DSS implementation and to examine the factors driving the success and failure. The workshop was attended by 15 distinguish researchers in DSS and environmental management field. Information about the workshop can be found under http://www.feem-web.it/dss-guide/

2) A survey targeting the DSS developers, consisting of 69 questions. Thirty eight respondents completed the questionnaire, making the return rate ca. 20%. The approached respondents included participants at the aforementioned workshop, lead authors of the DSS related articles published in the Journal of Environmental Modelling and Software and in the proceedings from the congresses of the International Society for Environmental Modelling and Software (iEMSs). A copy of the questionnaire is available at http://www.feem-web.it/dss-guide/survey.html.

[1] These recommendations are addressed more in detail in an extended version of this analysis prepared for a journal submission.

3) A survey targeting the DSS users. The questionnaire containing 26 questions was sent out by e-mail to DSS users suggested by the DSS developers. The questionnaire is described in Giupponi et al. (2007), a copy is available upon request.

3) In-dept review of selected papers published in the proceedings of the International Society for Environmental Modelling and Software (iEMSs), from the congresses in Lugano (2002), Osnabrueck (2004) and Burlington (2006). A sample of sixty papers had been drawn from a total of 141 papers referred to DSS.

4) Semi-structured interviews with the EU scientific officers from the Directorate General (DG) Environment and the DG Research. Further insights have been gained from less formal interviews and e-mail exchange with DSS developers and DSS users.

5) Analysis of the research projects funded under the FP4, FP5 and FP6, along with the review of the corresponding working programmes: The FP5 Programme "Energy, Environment and Sustainable Development" especially the key action line "Sustainable Management and Quality of Water"; FP6 Programme "Global change and ecosystems", and FP7 Programme Cooperation, thematic priority Environment (including climate change).

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