

# Bridging the research-management gap in environmental conservation: A case study from Andalusia, southern Spain

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## ABSTRACT

Science is believed to provide the most objective basis for effective decision-making, though it is rarely implemented in environmental management. Here we reflect on the results of a regional workshop aimed at exploring the knowledge and use of scientific evidence by environmental managers in an ecologically diverse region in southern Spain: Andalusia. Scientists were moderately aware of regional managerial needs. They stated that regional managers' needs could be mostly addressed by their research centers, and that they often considered managerial needs when conducting research. In turn, environmental managers had limited knowledge of, and interest in, the environmental research carried out in the region. However, managers stated they frequently use scientific outputs in their jobs. The main perceived barriers to effective use of science in regional environmental management by both groups were: different priorities by each group, and limited time of managers to check scientific information. Scientists also perceived that managers were not sufficiently engaged in research and that they were often reluctant to change their usual managerial practices. Managers mentioned inadequate scientific dissemination formats. The perceived solutions to those issues were: reinforcing collaboration mechanisms between both groups; aligning research to managerial needs more closely; greater managers' awareness of adaptive management; and developing user friendly, synthetic communication tools for managers. The insights from the workshop are intended to help scientists and managers to enhance effective use of environmental science in Spain and elsewhere.

**Keywords:** Barrier; facilitator; decision-making; science implementation; science impact

## 1. INTRODUCTION

Knowledge is a requisite for good decision-making (Cash et al. 2003; Nesshöver et al. 2016a). Science provides society with the most objective knowledge upon which policy making and managerial actions can be founded (Parks Victoria 2018). Nevertheless, even though the breadth of scientific knowledge in some disciplines such as environmental conservation is huge and expands quickly, that amount of rigorous knowledge is rarely used by practitioners for making better informed decisions (Arlettaz et al. 2010; Fuller et al. 2014; Nesshöver et al. 2014; Toomey et al. 2017; Walsh et al. 2014). The research-implementation gap is common in other research areas like medicine, public health, psychotherapy and education (Bero et al. 1998; Fixen et al. 2005; Wandersman et al. 2008).

Many researchers have studied why this gap occurs (Nesshöver 2016b; Young et al. 2013). Cash et al. (2003) developed the 'Knowledge systems for sustainable development framework', which looks at the research part of the equation. Rodríguez-Rodríguez et al. (2015) suggested major hindrances to the uptake of some research tools by environmental managers also on the side of managers.

Disconnection between science and management is likely to have important consequences such as sub-optimal decision-making, frustration by scientists and managers, and inefficient use of research and managerial funds (Cook et al. 2010; Nesshöver et al. 2016b). Actually, evidence-based interventions have become a requirement by some funding agencies in different fields (Wandersman et al. 2008) and are beginning to make the basis of environmental management in some conservation organisations (Parks Victoria 2018).

In Spain, some successful exchanges between scientists and environmental managers have occurred in some fields such as global change (Andalusian Government 2018a) or protected areas (PAs). The Spanish section of EUROPARC has engaged regularly with PA managers in the country through meetings, publications, projects and congresses since the 1990s.

It has produced a broad range of technical publications aimed at helping Spanish PA managers cope with legal requirements, international recommendations or scientific guidance (EUROPARC-España 2018). Notwithstanding those efforts and some progress, conservation science is still insufficiently used by Spanish managers despite substantial dissemination efforts (Rodríguez-Rodríguez et al. 2015).

Environmental management in Spain belongs to the seventeen-Autonomous Regions that also have broad law-making competencies on the topic. Thus, regional (sub-national) scale is the most appropriate one to assess research-implementation needs in this field in Spain. The managerial uptake of scientific knowledge could be particularly useful in such biodiversity rich country (CBD 2018; Múgica et al. 2010). Spain has the highest number of vascular plant species (around 9,000) of all the European and Mediterranean countries, with an endemism rate of around 23% (CBD 2018). One hundred and eighteen habitat types, 263 plant and animal species and 125 internationally important bird species occur in the country (Múgica et al. 2017). Furthermore, south-eastern Spain is considered one of the ten fine-scale biodiversity hotspots around the Mediterranean Basin in terms of plant species richness and endemism (Médail and Quézel 1999).

In this context, the European Topic Centre – University of Malaga (ETC-UMA 2018), a policy-oriented environmental research centre based in Andalusia, southern Spain, convened a joint workshop between scientists undertaking environmental research in Andalusia and regional environmental managers in order to: 1) understand managerial needs; 2) present recent research of potential interest to regional managers; 3) explore facilitators and barriers to the effective uptake of scientific knowledge produced in the region; and 4) explore expanded collaboration between regional scientists and managers. In this article, we reflect on the main findings from that unusual meeting for streamlining the use of science in environmental management in the region.

## 2. Methods

### Study area

Andalusia is located in the south of Spain (Fig. 1). It is the second largest Autonomous Region of Spain, with more than 87,000km<sup>2</sup> and the most populated one (INE 2018). It has rich biodiversity and a wide diversity of landscapes, geomorphological features and related cultural assets (Andalusian Government 2014).



**Fig. 1.** Location of Andalusia in the administrative map of Spain (not including the Canary Islands Region)

### Workshop participants

Two groups including regional scientists (n=11) and managers (n=15) were convened in a half-day exchange workshop at the Andalusian Ministry of Environment's headquarters in Seville in March of 2018. Regarding scientists, coordinators of environmental research projects with a focus on Andalusia that were undertaken by research institutions based in Andalusia in which the ETC-UMA had collaborated in the past seven years (2011-2017) were selected. Seven such projects were identified (Table 1). We classified the projects in three main topics that aligned with the organisational structure of the Andalusian Ministry of Environment: 1) protected areas; 2) ecosystem monitoring; and 3) climate change. Some other researchers that were interested in the workshop also attended and were surveyed.

**Table 1.** Research projects presented at the workshop

Research project	Leading institution	Topic
PANACEA	ETC-UMA	Protected areas
SOSTPARK	IEGD-CSIC	Protected areas
Med-IAMER	ETC-UMA	Protected areas
SWOS	Jena Optronics	Ecosystem monitoring
ECO-Potential	CNR	Ecosystem monitoring
CLICO	UAB	Climate change
ADAPTAMED <sup>a</sup>	UGR	Climate change

**ETC-UMA:** European Topic Centre-University of Malaga; **IEGD-CSIC:** Institute of Economy, Geography and Demography-Spanish National Research Council; **CNR:** Institute of Geosciences and Earth Resources-Italian National Research Council; **UAB:** Autonomous University of Barcelona; **UGR:** University of Granada

<sup>a</sup>This project started few months earlier than the workshop's date, so it was not assessed in the survey

The Andalusian Ministry of Environment invited heads of units and other relevant staff from its different working areas (Andalusian Government 2018b) to attend the workshop. Fifteen managers filled in the survey. They were unevenly distributed by Work Units: Agriculture & Fishing (47%), Protected Areas (13%), Environmental Administration (13%), Climate Change (7%), Environmental Education (7%) & Other (13%).

### Online survey

Two online semi-structured questionnaires with open-ended and closed-ended questions aimed at regional scientists and managers were produced using Google forms (Google 2018). A link to the questionnaires was made available through the ETC-UMA website. Both groups were given time to fill them in during the workshop using either their mobile phones or personal computers. Questions related to the following items: 1) respondent's field of expertise and affiliation; 2) degree of knowledge and consideration of current regional scientific work and managerial

needs; and 3) facilitators and barriers for effective implementation of scientific knowledge. The complete questionnaires can be consulted in Appendix 1. Interval closed-ended responses (e.g. degree of knowledge of managerial needs) were numerically coded using ordinal scales and descriptive statistics were computed (mean and standard deviation). Multiple-choice, closed-ended responses (e.g. barriers to use of scientific knowledge in regional management) were summed up and an overall rating for each choice was provided. Open-ended responses were reduced to few classes of similar meanings and computed according to their number of mentions.

### 3. RESULTS

#### Scientists

Scientists were aware of some research needs of regional managers ( $1.00 \pm 0.63$ , on a 0 to 2 scale). They thought that the research needs of regional managers could be partially addressed by their research centers ( $2.09 \pm 0.54$ , on a 0 to 3 scale). Regional scientists consider the research needs of regional managers occasionally to frequently ( $1.27 \pm 0.90$ , on a 0 to 2 scale). The perceived barriers to the effective uptake of regional scientific knowledge with the greatest agreement were: different priorities by scientists and managers (82% of respondents); managers are not engaged enough in research activities (82% of respondents); resistance to change managerial practices (73% of respondents); and managers' insufficient time to check scientific outputs (64% of respondents; Appendix 2). The measures to better integrate environmental science and management that were mostly agreed were: greater managers' awareness of the need of adaptive management (36.4% of respondents); organization of regular exchange events (27.3% of respondents); and developing research based on managerial needs (27.3% of respondents).

#### Managers

The degree of knowledge of the seven research projects was moderately low ( $0.67 \pm 0.49$ , on a 0 to 2 scale). The average interest of all projects to managers was medium to low (Table 2).

**Table 2.** Number of mentions of each research project by degree of interest by regional managers

Project	Interest to managers		
	Low	Medium	High
PANACeA	3	4	7
SOSTPARK	6	4	4
SWOS	5	6	3
ECOPOTENTIAL	1	2	3
CLICO	3	3	1
MED-IAMER	3	2	1
<b>Mean</b>	<b>3.50</b>	<b>3.50</b>	<b>3.17</b>

Environmental managers in Andalusia use environmental research from regional R&D centres occasionally to frequently ( $1.27 \pm 0.80$ , on a 0 to 2 scale). The main perceived barriers to effective uptake of environmental science were: different priorities by scientists and managers (agreed by 67% of respondents); inadequate dissemination formats (60% of respondents); and insufficient time to check scientific outputs (60% of respondents; Appendix 2). The measures to better integrate environmental science and management that reached the greatest agreement were: promoting contact between managers and scientists with joint capitalization actions (26.7% of respondents); making applied research lines coincide with local managerial needs, including final users (20% of respondents); and having a simple tool whereby to have easy access to research findings (20% of respondents).

### 4. Discussion

#### Status of science-management interaction in Andalusia

Even though the stakeholder and project samples that were assessed here cannot be considered statistically representative of Andalusia, some common patterns pointing to likely regional generalisations can be drawn from the workshop data. According to our results, the degree of integration of environmental science and management in Andalusia would be acceptable. Both groups are somewhat aware of the other group's work and consider it for their own work to a moderate extent. This may be due to the long-standing effort at environmental information compi-

lation by the Andalusian Government (Andalusian Government 2018c). In Andalusia there has been institutional interest in publicly disclosing and using research findings in environmental management for some time. As a result, substantial effort to systematically compile outputs from environmental research on the region has been made by the Andalusian Environmental Information Network since 2007 (Andalusian Government 2018c) so today the Network is the largest public environmental information repository in the country. Notwithstanding how important information availability may be, it does not guarantee its use in practice, or even the use of the most effective innovations (Wandersman et al. 2008). This makes us think that environmental science-management interaction in other parts of the country may be more limited, but this remains to be studied. Engagement experiences by environmental scientists in other Spanish regions showed a range of responses by managers: from enthusiasm to disregard or even hostility (Rodríguez-Rodríguez and Martínez-Vega 2013).

#### **Barriers to the use of environmental science**

There was some agreement on the main hindrances to the effective uptake of scientific knowledge in the region by both groups: different working priorities and time scarcity arose as common limitations to be addressed. Thematic and time priority mismatches between environmental scientists and managers have been commonly reported (Arlettaz et al. 2010; Cook et al. 2013; Nesshöver et al. 2016a) though they are somehow surprising in our case. On the one hand, applied science calls addressing the major societal challenges at European, national and regional scales exist in Spain (Andalusian Government 2016; European Commission 2018a; Spanish Government 2013). Actually, some of the projects presented at the workshop belong to those calls and yet they arose limited interest among practitioners, which could suggest deficient or too broad identification of societal needs by research administrators. On the other, research funders and environmental managers often belong to the same administrations in Spain (e.g. regional administrations), which would imply different, insufficiently coordinated agendas between research and environmental administrations. Moreover, some authors have

suggested that science, though slow at producing outputs, anticipates social needs thus going ahead of management which might not see the need to uptake scientific findings in contexts of unregulated topics and resource scarcity, even if they may deem such findings interesting (Rodríguez-Rodríguez et al. 2015).

Time constraints have long been blamed for the limited uptake of conservation science (Arlettaz et al. 2010). In Spain, recent budget cuts on environmental policies have severely affected managerial and scientific staff, so that fewer people with fewer resources have to deal with expanding managerial demands (Múgica et al. 2017).

Managers' complaints about inadequate disclosure of research outputs is old, widespread and well-known. Methodological, linguistic and language complexity (in the case of non-native speakers of English), length of common research articles, time needed to produce results (for research and peer review) and contradictions among findings have been largely blamed for their little use among environmental managers (Arlettaz et al. 2010; Cook et al. 2013; Nguyen et al. 2015; Walsh et al. 2014; Wandersman et al. 2008). Some synthetic, brief, user-friendly formats such as 'knowledge pills' were suggested at the workshop and elsewhere to overcome this frequent issue. Another common hindrance to research information use is scientific journals' embargos to non-subscribers such as most managerial agencies are, which greatly limits research dissemination to non-scientific audiences, especially in developing countries (Arlettaz et al. 2010; Fuller et al. 2014; Walsh et al. 2014; Wandersman et al. 2008). This dissemination issue is being progressively addressed by expanding open access policies by scientific journals and institutions (European Commission 2012; Fuller et al. 2014), although such policies bring about new ethical issues among researchers who may regard such policies as 'pay per work' or even been deprived of their right to publish if they have no allocated funds to do so.

Insufficient integration of managers in research was also highlighted by both groups. It may be the result

of scientists' omission by pursuing their own agendas or managers' refusal due to limited interest, time, will or skills to engage in research (Arlettaz et al. 2010; Rodríguez-Rodríguez et al. 2015). As pointed out by previous studies (Rodríguez-Rodríguez et al. 2015; Wandersman et al. 2008), insufficient uptake of science has two sides: science and management, although studies have tended to focus on scientific barriers (Cash et al. 2003; Cook et al. 2013; Courter 2012; Fox et al. 2006). In Spain, most environmental managers are civil servants. In addition to widespread staff scarcity that results in severe time constraints, managers are not usually awarded any form of recognition when taking part in research, which they must do voluntarily in addition to their usual workload. Thus, managers are often reluctant to participate in additional tasks that take time away from compulsory work (Rodríguez-Rodríguez et al. 2015). Similarly, scientists' merit is chiefly based on highly competitive academic achievements (*i.e.* publications) largely regardless of their outcomes which similarly discourage scientists to devote time and effort to engage in solving environmental problems more deeply (Arlettaz et al. 2010; Courter 2012). Social impact of science is starting to be considered by research funders (European Commission 2018), although neither guild has yet strong career-related incentives to engage more closely with the other in Spain.

Whereas environmental managers report to often have insufficient evidence to make decisions (Cook et al. 2010), managers' reluctance to modify managerial practices was an important barrier perceived by scientists and by almost half of managers, which tend to rely on custom, intuition or experience for making environmental decisions (Cook et al. 2010; Walsh et al. 2014). In some English speaking countries, most nature conservation managers were willing to change their managerial practices after being presented with a synthesis of effective wildlife management techniques, although more experienced managers were less willing to do so (Walsh et al. 2014).

Another point that was mentioned at the workshop was the gap between the timing of project cycles and managerial needs, so even when useful research out-

puts or tools (e.g. websites) are provided in a timely manner, lack of funding for maintenance likely results in those tools becoming outdated and abandoned by managers.

### **Facilitators for the uptake of environmental science**

Both groups agreed on the main facilitators for greater environmental science implementation in Andalusia. Conducting environmental research that is focused on managerial needs seems a sensible research policy to optimise outcomes in a context of environmental crisis (Butchart et al. 2010; Sanderson et al. 2002) and resource scarcity (Leverington et al. 2010; Múgica et al. 2017). Regular exchange events in the form of seminars, workshops or other meetings between managers and scientists could also greatly enhance timely awareness of managerial needs and available knowledge to tackle them or feasibility to do so (Arlettaz et al. 2010). The ETC-UMA workshop initiative was widely welcomed by both scientists and managers, which shows interest by both groups to interact more closely. Actually, the proposal to set up regular exchange events between regional scientists and managers reached broad agreement at the workshop, although the form and leadership of its implementation remain to be specified.

Some international research projects have looked closely at introducing science into management and decision-making (Nesshöver et al. 2014; Young et al. 2013; VVAA 2017). In other parts of the world, successful environmental outcomes have been suggested from integrative work whereby researchers have either been embedded in environmental organisations or have partnered with managerial agencies and other stakeholders to address specific needs (Arlettaz et al. 2010; Cook et al. 2013). In this sense, making better, more tailored use of the research potential of post-graduate students and early career researchers from hundreds of colleges and universities is advocated as a straightforward win-win solution in conservation science (Courter 2012). An example of such collaboration is the Research Partners Program in Victoria's protected areas, Australia (Parks Victoria 2018).

Interdisciplinary boundary organisations at the interface between science and decision-making (be it managerial or political) are also considered effective facilitators for a closer linkage between science production and implementation by adequately representing stakeholders, facilitating communication and exchange (Cash et al. 2003; Cook et al. 2013). The IUCN, the EUROPARC Federation and MedPAN have been mentioned as examples of boundary organisations on biodiversity conservation at different spatial scales (Rodríguez-Rodríguez et al. 2015). Knowledge networks have also been advocated for consolidating scientific views on contested topics, identifying research gaps to support relevant policies, and scanning needs to anticipate emerging issues (Nesshöver et al. 2016b).

Adaptive management means that managerial practices are modified according to the best available evidence, which science is a prominent source of but not the only one (Berkes et al. 2000). Adaptive management seems to be a reigning paradigm in environmental science (Gregory et al. 2006; Pahl-Wostl 2007; Perkins et al. 2011), though it is still rarely followed in practice (Cook et al. 2010).

The existence of simple, synthetic and easily accessible information of use to managers is considered a must for effectively bridging knowledge and practice (Wandersman et al. 2008). In other countries, evidence-based websites synthesizing scientific knowledge have been launched although their usefulness to practitioners is still unknown (Arlettaz et al. 2010).

Wandersman et al. (2008) distinguished among individual, organizational, community and contextual factors influencing innovation uptake. Researchers should be aware that, even if the best scientific information on the most effective innovations is made available to managers in the most accessible formats, a number of factors (personal, legal, financial, political, social, etc.) may still hamper their uptake (Arlettaz et al. 2010; Carbonetti et al. 2014; Rodríguez-Rodríguez et al. 2015; Wandersman et al. 2008). Going one step further, Toomey et al. (2017)

state that scientific evidence is just a minor factor influencing decision-making in multifaceted conservation issues and that it is unlikely to change value-laden attitudes. According to them, effective decision-making is primarily based on understanding values, knowledge, rules, behaviours and actions of stakeholders and the interactions among them during the research process, which would entail complex sociological research within conservation research (Fox et al. 2006).

### **Degree of knowledge and interest of presented projects**

The projects that were presented were only of limited interest to regional managers. This could be due to a number of reasons: 1) the projects' thematic restrictions in contrast to the broad spectrum of managerial thematic areas present at the workshop; 2) the limited presence of some project topics' managers at the workshop, especially on protected areas and biodiversity management, and the abundance of managers whose topics were little covered by the presented projects, like agriculture and fishing. This may have reduced the overall projects' relevance to attending managers; and 3) the projects' insufficient regard for interdisciplinary research involving natural and social scientists (Fox et al. 2006).

### **5. Conclusions**

Our results suggest that a moderate though improvable linkage between environmental science and management exists in Andalusia. Regional science is moderately based upon managerial needs and is fairly known and used by environmental managers. Different thematic priorities and time frameworks between scientists and managers and limited time to check scientific results outstood as the main (though not exclusive) barriers to effective implementation of environmental science in the region. The main perceived facilitators to overcome those issues were: undertaking management-oriented research and organising regular exchange events between scientists and scientific users. Even though representation of the two groups present at the workshop cannot be ensured, our results can help to spot the current state of the art in the region. We hope that the initiative

upon which this study is based will not be a one-off one but could evolve to become a regular forum whereby scientists and managers will work closely and effectively to improve the regional environment. We also hope that the insights from the workshop may help researchers and managers elsewhere to better deal with the common issue of insufficient and ineffective use of environmental science for wiser natural resource management.

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