

Absorptive capacity as a guiding concept for effective public sector management and conservation of freshwater ecosystems

Abstract

The ability of an organisation to recognise the value of new external information, acquire it, assimilate it, transform, and exploit it, namely its absorptive capacity (AC), has been much researched in the context of commercial organisations and even applied to national innovation. This paper considers four key AC-related concepts and their relevance to public sector organisations with mandates to manage and conserve freshwater ecosystems for the common good. The concepts are the importance of in-house prior related knowledge, the importance of informal knowledge transfer, the need for motivation and intensity of effort, and the importance of gatekeepers. These concepts are used to synthesise guidance for a way forward in respect of such freshwater management and conservation, using the imminent release of a specific scientific conservation planning and management tool in South Africa as a case study. The tool comprises a comprehensive series of maps that depict national freshwater ecosystem priority areas for South Africa. Insights for implementing agencies relate to maintaining an internal science, rather than research, capacity; making unpublished and especially tacit knowledge available through informal knowledge transfer; not underestimating the importance of intensity of effort required to create AC, driven by focussed motivation; and the potential use of a gatekeeper at national level (external to the implementing organisations), possibly playing a more general 'bridging' role, and multiple internal (organisational) gatekeepers playing the more limited role of 'knowledge translators'. The role of AC as a unifying framework is also proposed.

Keywords Absorptive capacity; Prior related knowledge; Knowledge transfer; Gatekeepers Social ecological systems; Systematic conservation planning; Freshwater biodiversity.

Introduction

Biodiversity assessments (e.g. Ricciardi and Rasmusen 1999; Loh & Wackernagel 2004) as well as South Africa's first National Spatial Biodiversity Assessment (Driver and others 2005) have concluded that freshwater ecosystems are in a much poorer state than terrestrial ecosystems. The primary responsibility for their management and conservation lies with government. The few recently established catchment management agencies (CMAs) in South Africa are also beginning to face the harsh realities of water resource management.

In an attempt to address the downward trend in freshwater biodiversity, great strides have been made in the last decade specifically in the relatively young field of systematic conservation planning. Developed primarily in the terrestrial domain, it is increasingly being applied in freshwater contexts to inform integrated water resource management (for example, see Nel and others 2009). Technically, scientists involved know how to identify what should be conserved and why (Nel and others 2009). At the policy level in South Africa, agreement has even been reached between various government departments on a common goal and a number of cross-sector policy objectives (Roux and others 2007; 2008a).

This increased focus on freshwater systems occurs while government organisations are also expanding their focus from single disciplines (e.g., botany, fisheries biology) to the more inclusive concept of biodiversity. Thus, many South African conservation organisations need tools to assist them with organisational transformation, efficient use of knowledge and rapid substantive changes to their conservation management and planning.

This paper assesses one such tool as it relates to the readiness of the responsible organisations, both national and regional, to these problems, which by their very nature are likely to require innovative solutions. 'Absorptive capacity' (AC) is a concept that has not yet been explored in the context of

freshwater ecosystem management and conservation by public sector organisations. It has been thoroughly researched in the economics and business management literature in the contexts of commercial organisations vying for competitive advantage (Lane and others 2002) as well as national innovation (Criscuolo and Narula 2002). The concept has been acclaimed as one of the most important constructs to emerge in organisational research in recent decades (Lane and others 2002). It was originally proposed by Cohen and Levinthal (1990) as the ability of an organisation to recognise the value of new external information, assimilate it, and apply it to commercial ends, later more simply referred to as their ability to exploit new technological developments (Cohen and Levinthal 1994). They argued that it is critical to the commercial organisation's innovative capabilities.

The flexibility of AC has been indicated by Schmidt (2005) suggesting that AC is an appealing concept to explore in the above freshwater context. The objective of this paper is to explore how AC and closely-related literature can provide insight into the freshwater ecosystem management challenge in South Africa. Our methodology was to examine that literature, understand the relation between AC and other management themes and synthesise selected key concepts into guidance for a way forward for freshwater management and conservation. An appealing possibility is that improved AC may also help in dealing with the pervasive problem of bridging the research-implementation gap, for example as noted by Knight and others (2007) in the field of conservation biology.

To provide a more concrete basis for the exploration, a specific case study context was chosen involving a scientific conservation planning and management tool currently under development. The tool consists primarily of a comprehensive series of maps that depict national freshwater ecosystem priority areas (NFEPAs) for South Africa. The NFEPAs project responds specifically to the reported degradation of freshwater ecosystems, both globally and in South Africa, using systematic conservation planning as a basis. With its core aim of planning for the long-term persistence of biodiversity, systematic conservation planning offers a practical tool for identifying those areas that

are critical for conserving biodiversity and those that are not. Importantly, the NFEPA project also recognised the need to develop an institutional basis to enable effective management of freshwater ecosystem priority areas at both national and regional levels of management, specifically relating to use of the envisaged project outputs. To be effective, however, information must flow freely between the planning process and responsible organisations. Those organisations must be able to assess and internalise myriad knowledge sources and types, make decisions based on that information and communicate that information to further contribute to the adaptive planning process.

Besides the maps, other information vehicles include guidelines and handbooks to accompany the maps. These target both water resource managers and land use planners. Key users are: the national Departments of Water and Environment Affairs, Catchment Management Agencies and their associated stakeholders, South African National Biodiversity Institute (SANBI), South African National Parks (SANParks), bioregional programmes, provincial conservation agencies, provincial environment affairs departments, municipalities and environmental consultants.

Absorptive capacity, organisational learning and adaptive management

Cohen and Levinthal (1990) claimed absorptive capacity is critical to an organisation's innovative capacity, which in turn is seen as a critical element for business (Welsch and others 2001). Innovative capacity is the ability to introduce a new and useful process or product into the market place. Public organisations also need to be innovative, partly because of the nature of the systems being managed but also because in developing country contexts human and financial resources are relatively scarce. They differ from the private sector in that they need to learn how to exploit new technological developments for organisational effectiveness and the public good rather than for private profit. Freshwater ecosystems are typically managed social ecological systems. These are complex adaptive systems, the management thereof characterised by uncertainty, an imperfect knowledge base and a

need for learning by doing (Rogers and others, 2000). It is specifically this uncertainty that demands a management approach that is adaptive. However, Rogers and others (2000) also note that there has been an unfortunate tendency to superimpose adaptive management on bureaucratic organisational structures that lack readiness.

Zahra and George (2002) emphasised the dynamic nature of AC, namely as “a set of organisational routines and processes by which organisations acquire, assimilate, transform and exploit knowledge to produce a dynamic organisational capability.” Todorova and Durisin (2007) re-conceptualised Zahra and George’s (2002) model and modified the core of their definition to “recognise the value, acquire, transform or assimilate, and exploit knowledge”. They had reinstated Cohen and Levinthal’s (1990) “recognise the value” as a step before acquisition and suggested that transform and assimilate are not consecutive, but rather alternative processes.

The definitions of Zahra and George (2002 and Todorova and Durisin (2007) lend themselves more naturally to public organisations. Importantly, these definitions explicitly identify AC as producing a dynamic capability. Dynamic capabilities reflect a firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (Teece and others 1997). The term ‘dynamic’ refers to the capacity to renew competences so as to achieve alignment with that changing environment. Identifying AC with dynamic capabilities specifically provides an even lower level, i.e. more practical, framework for understanding what an organisation needs to be able to do, i.e. recognise the value, acquire, transform or assimilate, and exploit knowledge.

Teece and others (1997) also suggest that innovative responses are required when time-to-market and timing are critical, the rate of technological change is rapid, and the nature of future competition and markets difficult to determine. In the context of the NFEPA products and public organisations, ‘time-to-market’ is equivalent to the time to uptake and effective use by the identified target users. Timing

is critical at least in the sense that considerable national interest, high expectations and significant momentum have been created throughout the map development process by ongoing stakeholder engagement and even deep involvement. Long delays could forfeit these advantages. Technological change is also rapid in this arena, particularly in the sense of new supporting data becoming available and in the increasing availability of new ways of processing such data. These factors contribute to a sense of urgency around the impending release and therefore justify the importance given to the need for organisational innovation in this paper, and the associated need to explore new concepts in this arena, like AC.

Teece and others (1997) suggest that the term 'capabilities' emphasises the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organisational skills, resources, and functional competences to match the requirements of a changing environment. So 'dynamic capabilities' is a core generic descriptor of the outcomes of those knowledge processes at the heart of AC, namely recognising the value, acquiring, transforming or assimilating, and exploiting knowledge. The management of AC will necessarily be very closely aligned to the kind of management suggested by Armitage (2005) in the context of adaptive capacity, namely reflecting organisational learning, experimentation and innovation. Indeed, this is adaptive management with the learning ideally characterised by effective feedback loops and genuine organisational change when necessary.

In the context of organisations that lack readiness for the use of adaptive strategies, there is a need to better understand what exactly "adaptive" means. The concept of adaptive capacity has been defined as management that reflects learning and the ability to experiment and foster innovative solutions in complex social and ecological circumstances (Armitage 2005). This is strongly aligned with the learning by doing proposed by Rogers and others (2000) and also links directly to the theme of organisational learning. Garvin (1993) proposed that a learning organisation is one that is 'skilled at

creating, acquiring and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights'. The lack of readiness implied by Rogers and others (2000) suggests a fundamental need for organisational change if the challenges of management and conservation of freshwater ecosystems are to be addressed effectively.

Practiced effectively, adaptive management creates an enabling environment and can result in an outcome described as adaptive capacity. A learning organisation, as defined by Garvin (1993), sheds a little more light on lower level outcomes, namely the ability to create, acquire and transfer knowledge, and modify behaviour.

This paper attempts to make the concept of AC even more practical in the current context by identifying and exploring a number of key related concepts in the literature.

Key AC concepts

The choice of key concepts built directly on our previous work relating to organisational social learning in the South African water and conservation sectors. Roux and others (2007) referred to AC's dependence on prior knowledge and how important such knowledge, social knowledge sharing and positive persistence were (among other principles) in enabling learning environments for good ecosystem governance. Roux and others (2008b) also argued that effective learning was essential for public sector organisations in South Africa particularly because they are often under-resourced in terms of infrastructure, finances and skilled people. They further noted that growing a successful learning organisation lies with its staff and motivation is an enabling condition for learning. A variety of existing issues within these organisations are not conducive to learning, many implicitly impacting on motivation. Finally, Roux and others (in press) described how a social learning approach, specifically involving informal knowledge sharing, helped multiple organisations co-reflect on the

nature of their cooperation and how facilitation of the process could be achieved through ‘bridging organisations’. While some public sector officials believe that learning happens primarily in formal settings, the importance of informal social learning has been consistent in the above-mentioned literature. AC provides a possible unifying framework for analysing and understanding these issues in a way that may leverage learning towards a dynamic capability within public organisations. The selected concepts and associated insights give substance to this framework specifically in the context of freshwater management and conservation, potentially providing a means for monitoring and managing AC.

Importance of in-house prior related knowledge

A core theme that has received much attention in the literature is that an important requirement for AC is an adequate degree of in-house capacity, specifically ‘prior related knowledge’ (e.g., Cohen and Levinthal 1994; Kamien and Zang 2000; Berry 2003; Vinding 2006). As Grünfeld (2003) notes, the reason for this is that an organisation needs specific competencies that enable understanding and ultimately exploitation of the ideas of other organisations. A certain level of competence is also required to undertake effective surveillance of external knowledge and technological development.

In commercial organisations the in-house capacity is multi-faceted and can be created in various ways. One is research and development (R&D). This is particularly relevant in the current context given the relationship between line function government departments and those organisations doing R&D for the public good, including universities, research councils and consultants. Originally linked to AC by Cohen and Levinthal (1990), the degree of R&D investment was also proposed as a useful indicator of the perceived importance of AC within an organisation. Their model suggested that it affects AC directly as well as indirectly through mediating the effects of technological opportunity

and appropriability (i.e. the ability to protect the benefits of new products or processes). The latter is less of an issue with organisations doing R&D for the public good.

Later, Cohen and Levinthal (1994) stressed the importance of prior related R&D knowledge, specifically noting that organisations with complementary in-house research are better able to exploit contract research. Similarly, in respect of manufacturing, direct involvement in the manufacture of a product makes an organisation better able to recognise and exploit new information relevant to that product market. In essence, no matter how freely accessible technological knowledge might be an organisation must typically have complementary in-house expertise to exploit it. This idea was again supported by Kamien and Zang (2000) who claimed that an organisation wishing to benefit from spill-overs that may become available from another organisation's R&D must engage in R&D itself.

Hicks (1995) also provides some insight into why R&D can be so beneficial. Organisations often do research for reasons that go beyond simply the desire to produce knowledge that they themselves can use directly. These concern linkage with the outside world, specifically "producing a window on what others are doing, help in recruiting or entry into other's networks". Furthermore, releasing information in publications builds credibility which allows the organisation, amongst other things, to better participate in the barter-governed exchange of scientific and technical knowledge (Hicks 1995). All of these can potentially contribute to improving the ability to recognise value of external knowledge, acquire and assimilate it and transform, and ultimately exploit that knowledge.

R&D managers, and indeed, in the current context, public service officials wanting to exploit R&D products, might ask at this point "how much is necessary?" Some insight comes from a study of some 2 000 innovative European organisations which found that R&D intensity (defined as the fraction of total turnover allocated to R&D), widely used in the literature as a proxy for AC, did not significantly influence AC (Schmidt 2005). However, continuous R&D engagement did. This is an important

finding, suggesting that R&D investment need not dominate the portfolio of investments aimed ultimately at innovation, although it needs to be constantly present. Schmidt also concluded that in-house capacity residing in highly skilled individuals and knowledge management tools that stimulate the involvement of employees in innovation projects seemed important for exploiting external knowledge.

Finally, Todorova and Durisin (2007) note that transformation enables organisations to perceive new knowledge that may be incompatible with prior knowledge. They state that while prior knowledge is critical, knowledge incompatible with it may also be important and this requires other capabilities to assimilate and ultimately exploit, like the ability to transform. This serves, first, as a reminder that pursuing a strategy of only building on prior knowledge may be inappropriate and, secondly and more explicitly, as a note of caution that specific efforts outside the comfort zones of prior knowledge are likely to be necessary.

Importance of informal knowledge transfer

Schmidt (2005) specifically emphasised the importance of knowledge transfer and organisational learning for AC, noting that they are multi-dimensional involving incentive provision, encouragement, empowerment, networking, and relationship building through face-to-face contact. This led to the hypothesis that R&D activities are not the only building blocks of AC but that the organisation and stimulation of knowledge transfer also play critical roles. Schmidt's (2005) results suggested not all collaboration methods influenced the ability to exploit external knowledge positively. However, those involving informal contacts were indeed important, also noting specifically that facilitating informal knowledge transfer was more important than a culture in which information provision was more centralised.

Todorova and Durisin (2007) commented on the moderating influence of social integration mechanisms noting that they can be both positive and negative depending on the type of knowledge and that they can affect all components of AC. They also noted that such mechanisms influence social interactions, for example through building connectedness and creating shared meanings, which in turn affect all knowledge processes.

Hicks (1995) emphasised that formalised representations of knowledge, like scientific publications, exclude two types of information that are also important. First, there is unpublished information. Secondly, there is tacit knowledge (i.e. that not easily articulated). In either case, informal face-to-face communication is an important alternative mechanism for knowledge transfer, a point also noted by Westley (1995) and Graf (2007). Mackay and Roux (2004) also noted how explicit knowledge can be “stripped from its human context” and how control can be lost over its subsequent use.

Informal knowledge transfer is likely to be as important for public organisations as for commercial ones. Whether or not it occurs will depend on the organisational structure and on the availability of mechanisms that enable such communication. These in turn will depend on the degree of management actively focussed on these issues, not only within organisations but also across wider learning networks that include external researchers and consultants and internal management and policy officials. In the context of uptake of a scientific product, informal knowledge transfer could play an important role in communicating NFEPA-related knowledge that is not easily conveyed explicitly within the products themselves.

The need for motivation and intensity of effort

Minbaeva and others (2003) found in the context of internal knowledge transfer in multinational corporations that both the ability and motivation components of AC need to be present in a subsidiary

to optimally facilitate the absorption of knowledge from other parts of the organisation. So while ability is important it is not sufficient. Motivation is also required. Todorova and Durisin (2007) also explicitly acknowledged motivation, suggesting, for example, that acquisition of external knowledge can be motivated by recognition of its value.

The intensity of effort, assumed here to be intimately dependent on motivation, required to create AC has been noted (Cohen and Levinthal 1990; Kim 1998). It was particularly evident in the way Korea's Hyundai Motor Company used proactively constructed crises as a means of opportunistic learning, specifically by requiring intense effort to deal with them. The challenge needed to be viewed in the sense of the two Chinese characters for 'crisis', one meaning 'danger' and the other 'opportunity'. The drive to doggedly, if not confidently turn what is a daunting problem into something constructive demands a special kind of motivation and hence intensity of effort. Kim (1998) suggested a good prior knowledge base and high intensity of effort were necessary for a high and rapidly increasing AC.

This is, in effect, a 'no pain, no gain' message. Creating and maintaining AC in an environment lacking motivation is not likely to happen without focused management and a pervasive determined mindset driven by common purpose.

The importance of gatekeepers

The presence of 'gatekeepers' was originally proposed by Cohen and Levinthal (1990) as contributing to AC. While the term 'gatekeeper' can have negative connotations (e.g. guarding or preventing access), it has only constructive connotations in the AC literature. They are individuals who provide a specialised interface between the internal system and external knowledge sources. They can also span boundaries within the organisation. They monitor the environment and translate external information

into a form understandable by the organisation. The gatekeeping function may be a structured centralised capacity or be diffused across many individuals.

Cohen and Levinthal (1990) also point out that the effectiveness of a gatekeeper is not only determined by the AC of that person. It also depends on that of the individuals to whom the information is being transferred. In other words, a shared knowledge and expertise is necessary. They also warn against the dangers of developing this shared AC to such an extent that a shared language develops to the point that they become so inward-looking or self-referential that it results in the not-invented-here syndrome. This can very effectively filter out potentially useful external knowledge, to the detriment of the organisation.

An interesting aspect of the above, implicit in Cohen and Levinthal's (1990) paper, is that, in a sense, to create AC you already need to have it. As just noted, effectiveness depends on the AC of the gatekeeper, more recently again formally hypothesised, empirically tested and confirmed by Graf (2007) in the context of regional innovation systems. However, it is this very gatekeeping that grows AC in the rest of the organisation and, inevitably, in the gatekeepers themselves. This highlights not only the potentially pivotal role of the gatekeepers but also that they will need to be people with special talents. Of course there will be an inherent limit to any individual's growth, which argues for the organisations need to develop and nurture gatekeeper capabilities in additional individuals at all times.

Graf (2007) also found that public organisations also serve the functions of gatekeepers to a higher degree than private ones. This was rationalised on the basis of issues such as their openness to science and their need to cooperate to acquire external funds. While this bodes well in our current context, the distinctive role and dual (external and internal) nature of gatekeeping are issues of particular relevance because biodiversity management and conservation are now specifically taking freshwater

ecosystems (i.e. new external knowledge) into account. A new shared language must develop, as indeed must a shared knowledge base, and the dangers of becoming self-referential over time should be borne in mind.

Boundary-spanning agents have been proposed as invaluable for creating a relatively risk-free space within which organisations can cooperate (Roux and others 2008a). However, the typically more conservative and restrictive structures of public organisations can be significant hurdles to realising AC. Not only does the importance of gatekeepers need to be officially recognised, to be fully effective they need to be officially sanctioned. Novel ways of achieving this within a government structure may be necessary if the full benefits of gatekeepers are to be realised.

One possible mechanism involves using external agents. The gatekeeping role could also be extended to a more comprehensive 'bridging' role. A 'bridging organisation' has been defined by Hahn and others (2006) as providing an arena for trust-building, vertical and horizontal collaboration, learning, sense-making, identification of common interests, and conflict resolution. To ensure the needs of the current context are met, the bridging organisation would need to focus on creating and maintaining a wholesome degree of collaboration between the organisations between which knowledge should flow. A useful analysis of factors affecting bridging in the context of inter-organisational collaboration has been presented by Yaffee and others (1997). The factors include those related to the situation (e.g. power imbalances, lack of communication, interpersonal chemistry, trust, etc.), process (e.g. lack of focus on process, lack of process management, etc.), the societal context (e.g. cultural norms, stereotypes and intergroup attitudes, etc.) and the institution (conflicting agency goals, organisational forms and culture, etc.). These clearly go far beyond the 'translation' context originally envisaged by Cohen and Levinthal (1990). Nevertheless, given the multi-organisational situation of the current context and the multi-faceted nature of bridging, the relevance of such a bridging agent, and its exact nature, may be worth considering even if it is only to address a subset of these issues. While there are

potential advantages to the use of an external agent, cognisance will still need to be taken of the importance of gatekeepers that span internal organisational boundaries, a need not necessarily always best served by external agents.

In summary, a strategy to facilitate broad-based uptake of a scientific product into a wide variety of organisations, including public sector organisations, should carefully consider the use of individuals, both internal and external to the targeted organisations. These can specifically act at the very least as ‘knowledge translators’ or more generally as bridging agents with a broader mandate that includes facilitating greater inter-organisational collaboration so that ongoing co-learning is optimised.

Synthesised guidance

This section explores how the above concepts and related insights can best guide freshwater management and conservation in South Africa and, more specifically, the uptake and appropriate exploitation of a scientific tool like the NFEPA products. The potential NFEPA product user base in South Africa is broad. The problems within public sector organisations alluded to above mean that uptake of such a product and transfer of the associated explicit, unpublished and tacit knowledge may be challenging. This is notwithstanding the momentum created among scientific and technical stakeholders within those organisations.

The analysis above has provided the theoretical basis for hypothesising that AC may be useful framework for improving the readiness of public organisations for such products. It has also identified four concepts that provide more specific guidance within the framework.

SANBI has the mandate to promote research and provide advice, upon request, on matters relating to biodiversity management and conservation in general, and more recently freshwater biodiversity in

particular, to the cabinet minister responsible for environmental affairs (amongst other tasks) (RSA 2004). This and the scientific nature of the NFEPA products naturally led to SANBI being earmarked for facilitating national organisational uptake. Constituted by biodiversity research and knowledge as well as policy and conservation management expertise, it receives funding from various sources one of which is the National Treasury. SANBI already works in partnership with a range of organisations, including research organisations, NGOs and other public sector organisations, often playing a coordinating, catalysing or facilitating role. Indeed, SANBI in many ways plays the role of a ‘bridging organisation’ as defined by Hahn and others (2006).

SANBI has considerable in-house science capacity. Its capacity relating to freshwater management and conservation, however, is still being established. This suggests that in the latter process it may benefit from careful consideration of the four AC concepts. From its perspective, the ‘new external knowledge’ has two dimensions, namely, freshwater management and conservation and, secondly, that relating specifically to the NFEPA products. Having recognised the value of such knowledge, SANBI’s new Freshwater Programme demonstrates their motivation to transform.

The discussion on ‘prior related knowledge’ above placed emphasis on how it relates to R&D. The current implementation model for research in the public sector is that it is not performed within line function government departments, either national or regional, i.e. those with the ultimate responsibility for managing and conserving natural resources, referred to here as the ‘implementing organisations’. In some sectors this research is undertaken by parastatal research councils whose responsibility it is to perform research ultimately for the public good. Within this model, public organisations, and indeed SANBI itself, would best create and grow the necessary prior related knowledge by engaging directly with external R&D both nationally and internationally. This SANBI already does extensively in a terrestrial context and now increasingly in a freshwater context. However, to enable the latter, at least a specific prior related knowledge in the form of an internal

“science capacity”, not a formal R&D capacity, is likely to be necessary. This must relate directly to freshwater management and conservation in general (for example, based on aquatic ecology and conservation biology) and to new scientific tools, like the NFEPA products, in particular. The R&D engagement should be based on awareness of ongoing research projects, their ultimate results as well as provision of strategic guidance on general research needs.

The national release of a scientific product may benefit from the gatekeeper concept by creating gatekeeping functions at two levels. A national level gatekeeper could facilitate knowledge translation and transfer between the primary knowledge sources (relating to freshwater management and conservation in general and, in this case, NFEPA in particular) and multiple organisational gatekeepers whose primary task it is to facilitate knowledge translation and transfer within their respective organisations. The national gatekeeper cannot be expected to understand the nuances of, for example, NFEPA-related requirements within each user organisation. Similarly, it may be difficult for individual organisational gatekeepers to maintain an adequate depth of knowledge transfer directly with the primary knowledge sources referred to above, and benefit from learning in other user organisations (even though this is made easier in a public organisational context because appropriability is less of an issue than in a commercial context). The two-level model limits the associated problems and creates greater potential for cross-pollination of ideas between individual organisations.

SANBI is well positioned to adopt the national gatekeeping role. It can also adopt a role broader than simply knowledge translation and transfer by becoming the above-mentioned bridging organisation, external to the individual implementing organisations, that facilitates inter-organisational product-related communication, co-learning, and collaboration when appropriate. Furthermore, by acting as a conduit to ongoing related R&D, it can also create the potential for direct R&D engagement by the implementing organisations. Depending on an individual organisation’s motivation in this regard, this

in turn creates the potential for absorptive capacity to be maintained and grown in these organisations in a way that increases their potential to be innovative in product-related and possibly other ways.

In respect of the individual organisation gatekeepers, an obvious choice will be those individuals who have already demonstrated enthusiasm for the product by their involvement in its development process. An advantage is that such individuals are likely to already have their own communication networks.

Scientific products are typically released using standard formal means (like printed and electronic maps, reports and manuals, and scientific publications). Few would question the appropriateness of this. However, we suggest that there also be explicit acknowledgement of, first, the existence of, and secondly, the potential importance of information and knowledge not easily transferred by such means. In effect, this acknowledges that the explicit products cannot be self-sufficient for all likely applications by a typical implementer. Other knowledge may also be required. This raises the importance of informal knowledge transfer mechanisms and suggests, for example, that members of the original scientific team responsible for developing the products (or people who were very close to the process) should make themselves available during implementation, particularly using informal mechanisms, to allow for the transfer of unpublished and especially tacit knowledge. The same kinds of mechanisms would apply to ongoing facilitation of co-learning among the implementing organisations themselves as uptake and use of the products increases. The exact nature and extent of informal mechanisms needs to be given enough attention in a sufficiently adaptive environment so that it gradually finds its optimum place in supplementing the formal mechanisms.

Face-to-face informal communication can also provide motivating opportunities. Both the national gatekeeper and the individual organisation gatekeepers can motivate basic uptake and use by accurately conveying, if not actually demonstrating, the value of the products. Notwithstanding the

existence of likely organisation gatekeepers (like those already exposed to the scientific product), the diverse potential use of the scientific product will mean that a significantly broader organisational knowledge base will be necessary to realise its full potential. The currently limited NFEPA-related prior knowledge base will mean that many will need to operate outside their comfort zones. This will require an intensity of effort even beyond that effort recognised as necessary for growing AC based on (more comfortable) prior related knowledge. This suggests special effort be put into establishing a powerful motivation to fuel the effort that will be required.

Motivation may be found to be lacking in parts of some organisations, perhaps due to job complacency or misguided by self interest or even corruption. If so, then this clearly identifies a potential obstacle to the uptake and use of new scientific tools. This again highlights the potential importance of carefully identifying the organisation gatekeepers, focusing on those with an established motivation whenever possible.

In summary, the above guidance can potentially produce an AC in implementing organisations that could facilitate initial product uptake and potentially create an ongoing dynamism in organisational routines and processes that is more likely to realise the full potential of the current scientific product and future ones. It is based on gatekeepers at two levels that facilitate appropriate prior related knowledge transfer giving adequate attention to informal mechanisms that also create and maintain motivation.

Conclusions

The current exploration of AC has been limited to only a few selected concepts and any conclusions drawn are not based on empirical evidence collected directly within this study. However, it has demonstrated that AC is a framework that is both intuitively sensible and potentially practically useful

for improving an organisation's ability to benefit from external knowledge. In this first application of its kind to freshwater ecosystem management and conservation, specifically in the context of a new scientific product of wide potential application in public organisations in South Africa, it has shown to be a framework that can potentially unify a number of organisational issues relevant to uptake of such a product. Indeed, it goes further by recognising AC as a fundamentally desirable capability in such organisations, which by the nature of the problems they face, need to be receptive to new ideas and also be fully innovative in respect of them.

The release of the NFEPA products provides a powerful research opportunity to put into practice the longitudinal research referred to by Todorova and Durisin (2007). If the uptake of the NFEPA products can be monitored and results analysed within the AC framework, the insights could help test the usefulness of AC that has become apparent in this paper, particularly as a unifying framework. More importantly for the future, it can also potentially help understand how such public organisations might actively and consciously, and realistically, pursue the dynamism of AC and hence become more generally innovative in future. In other words, the release of the NFEPA products can be a powerful case study for future organisational learning both in South Africa and beyond. It has the useful property that a wide variety of public (and other) organisations can be studied, providing a diverse data and information base. A useful start would be an empirical assessment of the current AC based partially on indicators suggested by Zahra and George (2002). It is also now evident that such an investigation can potentially provide insights into research-implementation gap issues, alluded to in the introduction.

Yet another research angle is the exact nature of the relationship between adaptive management and AC. The dynamic nature of AC, especially its inherent reliance of learning and change (specifically, transformation) seems well aligned with the ideals of adaptive management. Can an AC framework, and especially lessons learned from the uptake of the NFEPA products within public organisations,

help better understand how to address the problem of lack of receptiveness of such organisations to adaptive management noted by Rogers and others (2000)?

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