Supporting integration and co-development as processes of collective action and learning in catchment management in Australia

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Abstract
In this paper we describe preliminary results from an action research inquiry into knowledge making as part of a large integrated catchment research project, the Farms, Rivers and Markets (FRM) project. The FRM Project aimed to integrate academic research and community knowledge/s in the development of new water management options in an agricultural region, the Goulburn-Broken catchment in north-eastern Victoria, Australia. The preliminary findings of this research include the dynamics and processes that support integration amongst diverse disciplinary knowledge/s, and knowledge partnerships between integrated research projects and diverse communities of practice in agriculture and water management. We understand action learning to involve coordinating a variety of disparate practices and provide examples of how action learning (for improving catchment management) proceeds through two key processes of: integration and co-development. For each process, we describe the features that supported integrated research which included: careful planning as part of research design; facilitation of the emergent 'need' for integration/co-development; reflection and commitment; people-place connections; specialist skills in knowledge brokering; and shared decision-making and resource investment.

1. Introduction
The Farms, Rivers and Markets (FRM) project is a large integrated research project that aims to create opportunities to 'do more with less water' (The University of Melbourne, 2009). The project includes detailed modeling of farm systems and irrigation systems. It also includes ecological research. The project aims to develop better knowledge about the interacting systems of water use and management operating within a case study catchment (the Goulburn Broken catchment in northern Victoria, Australia). A better understanding of the possibilities and constraints within agricultural systems, ecological systems and irrigation delivery systems should enable the identification of opportunities to use water differently. However research outputs alone will not ensure the development of management options; success of the Project depended on the production of joint research outputs and understanding the implications of these outputs for the development of water management options. Therefore, one of the key challenges for the FRM Project was the integration of research and community knowledge/s in the co-development (Nettle et al., 2000) of new ways of managing water. We posit that the FRM project provides an opportunity for 'learning by doing' about how this integration can be achieved.

2. Background
The relevance and applicability of FRM research to farms, water managers and policy makers in the case study catchment and other catchments is dependent not only on the biophysical, economic and technical feasibility of new options in farm systems, water markets and river

management but on the learning and management challenges for individual farm businesses and stakeholders in adapting their practices to suit changes in the environment and markets. However, most biophysical research projects fail to account for and consider the implications for practice of research outputs. Changing production systems or water management on-farm is not just about economic and technical feasibility but involves the motivations, management capacity and risk perceptions held by farmers and rural communities alongside their specific production and lifestyle cultures. In addition, changes to the way regulated and unregulated water supply is used and managed is not just about what is technically feasible but involves the policies, procedures and practices of organizations. It involves addressing the questions of "what do we need to *do* differently?"

We conducted research into the community engagement and *practice* dimensions of FRM research by identifying disconnects between research and practice; exploring opportunities for changing practices, and; documenting and evaluating the integrated research (innovation) process for the benefit of other catchments. The central research question of this study was: How do diverse communities integrate knowledge/s and options for improving catchment management?

Studies of collaborations in integrated research teams have highlighted the need to investigate further the dynamics of integrative processes including: ways to have conversations about difference (Dunn 2010); how to design 'genuine partnerships between science and community or 'industry' (Martin et al., 2010, p. 38) how to measure progress in integration (Jeffrey 2003); and understanding the intellectual and organizational resources required to support integrated research (Mollinga, 2010).

Research institutions, researchers and policy makers have examined the value of integrated research for addressing complex problems of natural resource management (NRM) (Bammer et al., 2005, Lane and Robinson, 2009) including landscape management (Tress, 2005, Dovers, 2005), water management (Martin et al., 2010) and climate change. Few studies, however, have examined these claims with respect to how integrated research produces this value and the extent to which integration can be managed more effectively or greater value derived. In other words, does integrated research just happen? And will any integration do?

3. Our research and practice approach

3.1 A multi-dimensional framework for community engagement: Identifying multiple communities and multiple engagement purposes

Although the importance of engaging with the people that can contribute to, influence or be impacted by research or policy change is well accepted, research has identified constraints to improving sustainability efforts via community engagement. Harrington et al. (2008) identified the discourse for community engagement to be problematic, as concepts relating to community participation have been unclear (who is the community and what constitutes participation?). Second, the focus has been misdirected, with an overemphasis on engaging communities of place (where communities of practice, or communities of interest, may be more important).

We suggest that there are three community types that are central to successful knowledge co-development in the FRM project:

- **Research disciplines**. The FRM team includes researchers from a range of different disciplines (farm systems modeling, freshwater ecology, engineering etc). Developing options for improving agriculture and water management requires detailed research work

within disciplines, but also communication between disciplines, and the engagement of each research community with other research communities (see below).

- **Communities of practice**. Water management options will enter catchments through the practices of farmers, water managers (both environmental water managers and irrigation system managers) and policy makers. Engaging with these communities of practice and understanding the implications of proposed water management options for their practices is central to achieving changes in catchment management.

- **Communities of interest**. These are the groups and their institutions that have an interest or 'stake' in the outcomes of the Project. The key communities of interest are represented by the: project steering group; and the local (catchment) community which includes rural industry groups, catchment residents, and recreational users of water and waterways in the catchment.

This analysis of community types provided us with a conceptual framework for understanding action arenas for doing collective knowledge making in the FRM Project. We summarise these arenas as follows (represented diagrammatically in Figure 1 below):

- Action arenas that involved multiple research communities within the FRM project (for example whole-of-project team meetings, working groups involving researchers from several modules, informal interactions around the preparation of papers and reports).

- Action arenas that involved interactions between particular parts of the FRM project and particular practice groups (for example, farmer reference groups connected the Farms module with practicing farmers in the catchment; the catchment reference group connected the Rivers and Markets modules with irrigation managers and environmental water managers);

  Action arenas that involved interactions between the FRM project as a whole and one or more communities of interest within the case study catchment or beyond (for example, the Steering Group provided an opportunity for the FRM project team to connect with catchment management experts; two focus groups with diverse communities of interest in FRM on the relevance of FRM research to practice and policy were conducted).

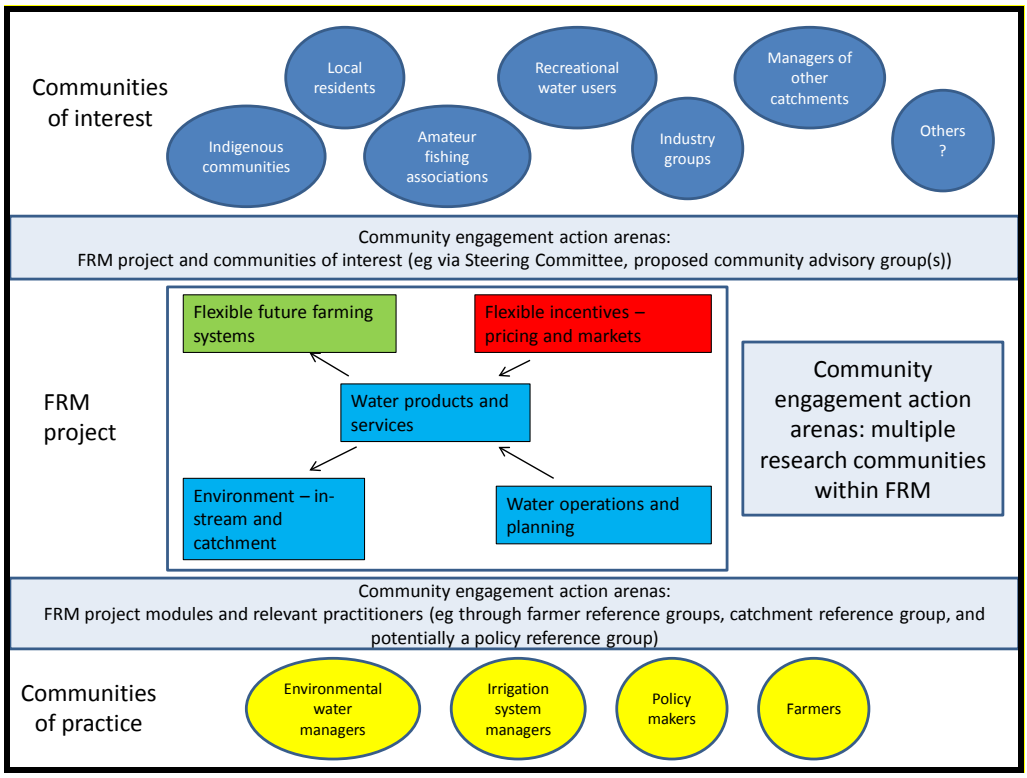

Figure 1: Community engagement framework for integrated research (FRM Project) (Love et al., 2010)

3.2 Knowledge production as an outcome of collective practices

In this paper we assume a model of knowledge production that focuses on cooperative practices as configuring the relationship between innovation and agricultural and natural resource management policy and practice change. We have previously argued that paying attention to the processes of integrated research can result in projects where there is a better connection between research outcomes and the needs of industry and communities, and consequently more progress towards addressing complex problems such as integrated catchment management (see Love, Ayre and Nettle 2010).

We want to suggest that an alternative model of knowledge production to that of the uni-directional transfer of technology model (Vanclay, 2004)—typically, called 'R, D & E'. The 'transfer of technology' model of innovation defines locates knowledge production and social endeavour in the separate domains of 'research' and 'development' and 'extension'. In circumscribing these domains, the model effects a strategic distinction between activities that 'represent' and describe so-called normative *real-world* conditions and objects' (the activities we describe as 'research') and those that enact, translate, adapt or apply these activities and objects— the activities traditionally described as 'development' and 'extension'. Here we want to challenge this distinction by using an alternative model that takes all scientific knowledge work to be the outcome of heterogeneous, collective practices involving a diversity of actors. This framework has been well developed in studies of science and technology and the social studies of science, where all knowledge, including the subjects and objects of the scientific enterprise, are understood to be the outcome of sets of diverse, collective and coordinated practices (Mol,

1999, Law and Mol, 2000, Shapin and Schaffer, 1985, Hess, 1997, Callon, 1986).In this framing, the activities of 'research', 'development' and 'extension' are dissolved as distinct stages or domains in an endeavour such as FRM.

3.3 Research and Practice Framework

An action research inquiry was chosen as the basis for data collection and analysis in the FCNIR sub-project (Carr and Kemmis, 1986). Focusing on three case studies of the FRM project communities of inquiry (see Figure 2 below), we undertook a study of integration and co-development in the FRM project. The focus of our action and inquiry was to enhance connections between communities for the development of catchment management options (developing and implementing the community engagement process) and critically reflecting on this action to better understand how and why it contributes to improved development of catchment management options. We sought to both understand the collective experience of doing FRM as integrated research, as well as design and evaluate effective and timely interventions to support the research. This involved a variety of methods such as: participant observation; ethnography; interviews; group activities (workshops, focus groups, meetings etc); and textual (document) analysis.

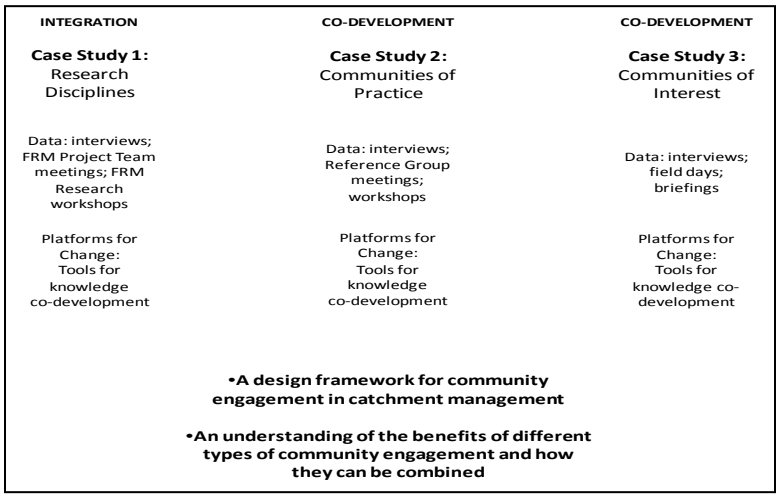

Figure 2: Research and Practice Framework for the FCNIR sub-project

3.4 Understanding the key processes of integrated research

We examined the FRM Project, as a case study of integrated research, through two lenses of collective knowledge work: that of 'integration' and 'co-development'. We recognize that these two processes are interdependent in practice however for the purposes of our analysis we have defined them as:

1. 'Integration' is defined as a process of coordinating diverse (scientific) disciplinary practices and knowledge/s to address common research objectives (agreed goals). Integration in the FRM project refers to the processes of working together 'within' the FRM research team.

2. 'Co-development' is defined as a type of formalised partnership which aims to co-produce the knowledge and practices required for management (new knowledge and devices) to

meet industry and government challenges. These 'knowledge partnerships' are viewed as a potential way to enhance and support learning in an area (Kenny and Nettle, 2006). Co-development in the FRM project refers to the processes of diverse scientific and non-scientific actors working together to develop concepts, tools, approaches or technologies that are appropriate for catchment management.

In the following sections of this paper we briefly describe some preliminary insights into integration and co-development as action learning (collective knowledge-making) processes. We consider some of the kinds of roles, skills, people and places needed to support integration and co-development for improving catchment management.

4. The challenges of learning *how to do* integration together

4.1 FRM research workshops: site of integration.

Sites of integration (Boxelaar et al., 2007) were the combinations of people and places from which new research and practice insights emerged in the FRM Project. A key site of integration for exploring and supporting inter-disciplinary work to achieve common project goals in FRM was the FRM Research Workshops. Held every six months, these whole-of-project activities were designed and organised by FCNIR sub-project researchers in collaboration with the FRM project Team. The main challenge of these workshops was to support integration so FRM researchers could go on together with more certainty and in more coordinated and focused ways to deliver high quality, joint project outputs.

The key (generic) questions addressed at the workshops were: *What* are the individual and group contributions to achieving common FRM research goals? *Who* do we need to work with? *How (and when and where)* do we work together? (i.e. what interactions, materials and representations (i.e. data, models etc) are required?). Each workshop was an important forum for progressing integration in FRM and was iteratively improved both in design, active participation levels and feedback. FNCIR researchers developed the agenda for the workshops. The key design elements of these workshops were participatory 'integration' sessions (involving group work, collective reflection, mutual questioning etc). In these sessions, devices (strategies) to support integration were designed and emerged from the collective inquiry and actions of FRM researchers. One such device was a set of *Principles and Criteria for Integration in FRM*. These emerged as a way of negotiating a collective understanding of what 'integration' is in the FRM project and assessing progress towards this 'integration'. One FRM researcher noted:

> *This is about defining what we [FRM researchers] think integration is and assessing that integration, not the integration itself.*

This comment demonstrated an understanding of the generative nature of 'integration in FRM'. FRM researchers understood integration in FRM as a 'process', however, they also recognised the importance of defining 'outputs' as the goals of integration to help define this process. For example:

> *Having clear end-points from integration processes is important. Outputs are important (for integration) as they define a goal (e.g. a paper).* (R. Nettle field notes, 22 November 2010.)

4.2 Generating a collective understanding of the 'demand' for integration

Generating a collective understanding of the demand for and benefits of integration was another important challenge of integration in the FRM project. Integration was at times considered by some researchers as only incidental to the effectiveness of producing FRM research (see Clark and Ayre 2011). It was not always necessary to work in an integrated way to produce certain

elements of FRM research. However, knowing *how* to integrate and *when* (it is required) was part of the process of learning together to *do integration* in FRM. As an object of our individual and collective inquiry, 'integration' was necessarily a contested entity and was represented in the Project in multiple ways. Different people had different narratives and theoretical and practice frameworks for understanding how integrated research work might or should proceed. Their experiences of integration were also varied.

4.3 Measuring progress in integration

From our inquiry, we understand integration as a generative process that must be measured, at least in part, in terms relative to the kinds of research questions and goals posed; the object of integration (Luukkonen and Neveda, 2010) the level of experience of those involved at 'doing integration'; and the resources available to manage and actively support integration. For example, FRM researchers recognised that measuring progress in integration is a complex matter. Some members of the FRM research team reflected that the draft *Criteria for Integration in FRM* were inadequate to deal with the recognised phases of integration in the project.

> *There are phases of integration. It would be good to have some measures of efficiency and sufficiency (of integration)). The current criteria don't cover these phases. They are too complex.* (FRM researcher, personal communication in Clark and Ayre, 2011)

The ability to publish integrated journal papers from the project will be an important demonstration of the value of integrated research to those involved and may consolidate both learning about how to do integration, as well as the benefits and incentives for doing it.

4.4 'Paying attention to' integration

Researchers in FRM demonstrated a nuanced understanding of integration through their collective experiences of doing integration together. For example, they recognised 'integration' as a 'process' (not an end-point)' with both 'planned' and 'intuitive' aspects (see Martin and Ayre, 2011). As the project progressed, there was a growing sense of ownership and interest in integration among researchers which included an articulation of what integration meant to them, how it proceeded in practice and how it can be represented in project outputs. By actively problematising and facilitating the processes of integrated research, learning opportunities were enhanced and new possibilities for working together to change catchment management emerged. However, interdisciplinary research teams must commit time, energy and other resources to 'paying attention to' or problematising integration. Integration can be a time-intensive and intellectually demanding process and requires support in the form of: strong leadership and participatory activities that bring researchers into contact with one another.

5. Co-development

5.1 'People-places' as sites of co-development

Researchers in the FRM project worked with farmers, water managers and other stakeholders to develop research outputs, manage farming systems trials and explore the practice and policy implications of FRM research. The concept of co-development as a 'formalised knowledge partnership' (Nettle et al., 2000, Kenny and Nettle, 2006) was used to underpin the planning and design of co-development activities in the FRM Project. Our preliminary findings include that a sense of ownership, and therefore commitment to co-development was enhanced by sites of co-development which had strong associations between practitioners and researchers in catchment places—or 'people-place' (Ayre, 2010) connections. For example, the FRM Farms research program worked with a leading farmer to establish field trials on his commercial farm. The farmer involved had strong links to social networks of farmers in the catchment and assumed

responsibilities for: promoting the research to the wider farming community (through his networks); engaging in the everyday decision-making on trial management; and, managing the tensions between the imperatives of research design and realities of trial (and commercial farm) management. Partnerships with key individuals resulted in this farm concerned emerging as a key site of co-development in the FRM Project. This site required ongoing investment in terms of both the farmer's own resources (i.e. his/her labour, practice knowledge, equipment and paddocks etc), resources of the associated farmer networks involved in attending field days etc (i.e. their time; farming expertise), and FRM research management (in particular, field staff with strong engagement skills).

5.2 Identifying co-development ' needs'

Similar to the processes of integration in FRM, a recognised development 'need'[1] is a crucial design element for co-development. For example, where the development needs of farmers and water managers were understood and addressed in FRM as a starting condition of working together (i.e. in the farmer reference groups), relationships characterised by action learning were strengthened. However, development needs are not static. They must be iteratively re-performed through ongoing shared decision making and priority setting between collaborators. This generative development 'need' will emerge from sites of co-development in FRM (see above) where people engage together to continually share knowledge, re-negotiate and reflect on research and practice challenges.

5.3 Recognising the 'value' of co-development

From our preliminary analysis of results in this research, we found that members of farming communities of practice engaged in the FRM project recognised the value of co-development both to themselves and to their communities as stakeholders in the research. As individuals, they recognised their role in FRM provided an opportunity to: participate in 'leading-edge research'; contribute industry expertise in their catchment; and satisfy learning needs. Members of the farming practice communities identified their responsibilities in FRM as: ensuring' accountability' to investors and the broader public (Broad acre CoP member); extending research through their practice networks; and managing risk through identifying 'realistic' (Ibid.) and meaningful new research goals. This risk management role was identified by farmers involved as an issue of recognising practitioners' knowledge and accounting for this knowledge in the design and conduct of farming systems trials.

Conclusion

We suggest that a trajectory of change for improved catchment management research involves people and their practices at all stages of inquiry and enactment—from the genesis of questions for 'research' to the validation of data or new information; to the proposals for practice change and the actual change itself. In this paper we have described insights into key action learning processes of 'integration' and 'co-development' as both *planned* (part of research design) and emergent (iteratively designed). These processes are supported by: collective action, reflection and commitment; people-place connections; specialist skills in knowledge brokering; and shared decision-making and resource investment. Recommendations to help maximise the opportunity for practice and policy change from integrated research efforts are given below (from Ayre and Nettle, 2012).

[1] Or what Klerkx and Leeuwis (2008) call a 'demand articulation'.

Recommendations

For interdisciplinary research teams:

- An imperative or framework for integration must be part of the design of integrated research projects.
- Integration needs to be actively managed and supported (facilitated) to identify and support the changing 'needs' for integration throughout interdisciplinary collaborations.
- Resources, skills and roles to support integration (i.e. social science/innovation research and facilitation expertise) should be included in the research project design.
- Roles and responsibilities for motivating and being accountable for integration should be agreed at the beginning of research projects.

For research institutions:

- Seek to champion integrated research projects by showcasing research findings (i.e. in symposia and other public events).
- Provide incentives to researchers to do integrated research through faculty-based means of recognition (i.e. awards; interdisciplinary seed funding).
- Promote efficiency in the administration of integrated research projects through transparent and well resourced centralised project management.

Recommendations for working with communities of practice in integrated catchment management:

- Communities of practice should be engaged in the conception and planning phases of integrated research projects to identify development 'needs' and align these with research priorities.
- A commitment to continuous engagement with communities of practice through both informal (ongoing) mechanisms should be formalized and adequately resourced.
- Formal partnerships with commercial farms should be considered as a strong basis for co-development. Government, industry and community service providers and extension (change) agents along with leading practitioners should be explicitly engaged early as key knowledge or 'innovation brokers' in integrated research projects to help identify co-development 'needs' (or 'demand articulation' (Klerkx and Leeuwis, 2008).

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