

[a]Chapter 9: Opening up Catchment Science: an Experiment in Loweswater , Cumbria, England

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[b]Introduction

This chapter reports on an attempt, by academic researchers, local residents, businesses and institutional stakeholders to think through and carry out catchment science, catchment management and catchment participation simultaneously. ‘Understanding and Acting in Loweswater: A Community Approach to Catchment Management’ was a project supported by a three year Rural Economy and Land Use (RELU¹) grant and took place between 2007 and 2010. It involved the creation of a new body of lay and scientific research about the catchment of Loweswater, Cumbria, within the Lake District National Park in North West England. It also supported the creation of a new ‘social mechanism’, the Loweswater Care Project (LCP), which drew in, supported, scrutinised, criticised and monitored this research. All of the research was connected, sometimes directly, sometimes indirectly, to a persistent problem – the presence of potentially toxic blue-green algae (cyanobacteria) in Loweswater lake (the village, the catchment area and its lake share the same name). We describe below the origins and formation of the LCP, the ideas and commitments that underpinned it, and the consequences of its work to date.

[b]Context and Drivers

The 2007-2010 project was led and carried out by an interdisciplinary team of natural and social scientists from Lancaster University and the Centre for Ecology & Hydrology (CEH),

Lancaster, one ‘community researcher’ (a farmer based at Loweswater), local residents, farmers, and institutions with responsibilities for environmental quality regulation and policy. The research aimed to improve the way that these relevant actors understood and acted upon the occurrence of potentially-toxic blooms of blue-green algae in the lake. The researchers also wanted to experiment in the development of more inclusive and integrated forms of catchment management, as called for by the European Union (EU) Water Framework Directive (WFD). To do this they drew on ideas of public participation in science and policymaking that long preceded the EU Directive (Tsouvalis and Waterton, 2012). Water quality had been deteriorating in Loweswater over several decades up to, and into, the 2000s, and conventional means of tackling the problem (scientific monitoring and regulatory interventions from 2001 onwards) appeared to have had little impact by the time the project began in 2007. Blue-green algal blooms, which are normally unusual in the colder months, were by this time becoming a regular occurrence during the winter. The problem seemed to be intractable and prompted both concern and debate within the local community and the institutions involved in the management of the catchment.

The research addressed blue-green algae in Loweswater through both ‘inter-disciplinary’ and ‘participatory’ methodologies. It aimed, first, *to create a mechanism* that would enable decision-making by local residents, institutional stakeholders and social and natural scientists together. Decision-making had as its objective a deliberately broad goal – the long-term ecological, economic and social sustainability within the Loweswater catchment. Thus, the LCP became a forum that opened up, rather than narrowed down, questions about what is at stake, ecologically, economically and socially for Loweswater, and possibly for other places like it. Second, the research aimed to *carry out high quality interdisciplinary*

research in order to produce a catchment knowledge-base to inform such decision-making. The latter included research into; upland farm economies, land and water ecology, institutional ‘governance’ and responsibilities for land and water quality, local understandings and knowledge of Loweswater, and socio-economic and cultural challenges faced by the residents. Findings from this research were shared via the LCP, the social mechanism created for the project. The LCP consistently drew local residents, institutional stakeholders and researchers together for challenging debates over a two and a half-year period. Although the RELU project itself has ended, the LCP is now sustained and directed by local residents.

[c]Catchment Background

Loweswater is situated in a relatively quiet area of the Lake District (in terms of visitor numbers) and the catchment was previously designated as a ‘quiet valley’ by the Lake District National Park Authority (LDNPA)². Relative to other Lake District lakes, Loweswater is one of the smaller, shallower lakes and has been characterized as ‘eutrophic’ (Maberly et al, 2006, 2011). The catchment covers a land area of 7.6 square kilometers which feeds into the lake, itself 0.6 square kilometers in area. The lake is owned by the National Trust (NT), whilst the land area draining into the lake directly and via a number of streams comprises a mixed lowland/upland partially wooded catchment with steep sided valleys to the north-east and south-west and gently sloping or level fields at either end of the lake.

Uniquely for a lake in the English Lake District, Loweswater drains towards the centre of the Lake District and into another lake (Crummock Water) at its south-eastern end. Loweswater has a long residence time for a Lake District lake of its size, and water entering the lake will remain in it for an average of 150-200 days. It is rich in submerged macrophytes (aquatic plants) whilst the shores include only small patches of species rich emergent vegetation. It is used infrequently for recreational fishing, mainly for brown trout (*Salmo trutta*), and it produces only low catch rates, although in the past the lake has served as an important recreational fishery. The main inflow enters Loweswater at the north-western end of the lake after passing through lowland farming and sparsely populated residential areas. Currently there are eight farm holdings that have 'in-bye' pastures (high quality fertilized grassland) inside the catchment. The catchment has a population of approximately 45 permanent residents, and hosts around half that number again of visitors on a year round basis in different forms of lodging around the lake (a camping barn, bed and breakfast accommodation, a small hotel and rental cottages).

Loweswater is afforded no special designation apart from its inclusion in the Lake District National Park. As part of the former Lake District Environmentally Sensitive Area (ESA) all farmland was at one time included in the ESA agri-environment scheme enabling farmers to access funding for management of farmland including capital works such as hedge re-creation. Most ESA agreements finished around 2008, if they were not renewed at that time. Renewed agreements finished during 2013. Currently, upland areas in the catchment fall under the Moorland designation made by the Rural Payments Agency in England. This designation influences payments made under the EU Single Farm Payment Scheme and under new European agri-environment schemes brought in to replace the ESA scheme.

Lowland agricultural areas, known as ‘in-bye’ land, are classified as ‘Severely Disadvantaged’ because of their low agricultural potential.

[c]Water quality and quantity problems; the issues and their severity

Loweswater experiences regular blooms of blue-green algae some of which can be toxic to both animals and humans under certain conditions (Codd, 2000; Maberly et al, 2006). In the past, the NT placed warning signs around the lake advising people to keep themselves and their dogs away from the water. Algal blooms are a major water quality issue for Loweswater affecting the use of this amenity by visitors, local residents, livestock and other animals. Water quality in the lake has been estimated to be ‘Moderate Status’ under the EU WFD classification (Maberly et al, 2011) and long-term lake monitoring data show that the blooms are a response to high phosphorus (P) levels in the lake (Maberly et al, 2011). As it is a small rural catchment the primary sources of nutrients to the lake include septic tanks serving residential and visitor accommodation, livestock farming and fertilizer application.

[c]Existing organizational and institutional structures concerning water quality issues at Loweswater

Despite being a relatively small catchment area, the governance and management arrangements for Loweswater are complex. The farmers make key land management decisions, but there are several public and charitable organizations which can also affect how land and water are used and managed by setting the policy context, establishing regulations and offering incentives. The Environment Agency (EA)³, Natural England (NE)⁴ and the LDNPA are important players because of their statutory responsibilities and

powers. In addition, as the owner of the lake itself and a proportion of the surrounding land area, the NT, as outlined above, is a significant institutional ‘actor’ with a particular interest in maintaining and improving water quality at Loweswater.

The EA has wide-ranging statutory responsibilities for the protection of the environment, including water resources, and the promotion of sustainable development in England and Wales. Among the legislative controls it has available for the control of diffuse nutrient inputs from farming are, for example, the Water Resources Act 1991, the Environmental Permitting Regulations 2007, the Nitrate Pollution Prevention Regulations 2008 and the Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations. However, following recognition that farming is a key source of diffuse pollution the EA has called for a new approach to the management of water quality using a ‘whole catchment approach’. This places strong emphasis on the greater use of voluntary measures which can provide ‘win-win’ solutions for farming and the water environment, and arguably lends itself to a decision making mechanism such as the LCP.

At a European policy level, the EA implements the EU WFD across England and Wales. The WFD requires all inland and coastal water bodies to be at or reach defined standards for ‘good ecological status’ by 2015, with subsequent six-year cycles of river basin planning and management to improve conditions where initial ecological and chemical targets are not achieved. For the WFD, Loweswater is included in the Derwent catchment area which is part of the North West River Basin District (NWRBD). In the NWRBD, seventy percent of surface waters (512 separate water bodies) were classified as failing to meet good ecological

status in 2009. However, planning focuses on large geographical areas and the amalgamation of water bodies for assessment purposes has meant that particular conditions and water quality problems in small lakes such as Loweswater are obscured and effectively 'lost' in the process. Even though Loweswater is currently at only 'moderate ecological status' it seemed unlikely that the first WFD river basin planning and management cycle which runs until 2015 would have a significant impact on the Loweswater catchment.

The England Catchment Sensitive Farming Delivery Initiative (ECSFDI), which nationally is a significant funding and advice mechanism for addressing diffuse pollution and water quality, is included in the responsibilities of Natural England (NE). The ECSFDI involves close cooperation between farmers and NE in the development and implementation of soil and nutrient management plans and effective applications of manures, both aimed at reducing inorganic fertilizer inputs. In addition to advisory services for farmers, a capital grants scheme is available in designated priority catchments. However the ECSFDI has only been applied to selected 'priority' catchments in England. Following discussions in 2008/9 with representatives from NE regarding the possibility of Loweswater being included in the priority area, the LCP was informed that this would not be possible. This, paradoxically, was due to the fact that Loweswater farmers were already working together on the problem of diffuse pollution. The ECSFDI was targeted at those areas where awareness and action on diffuse pollution was limited or non-existent, whereas Loweswater was a site where there was already significant concern and desire to act. The exclusion from the ECSFDI at this time was seen as unfortunate by Loweswater farmers who were keen to attract capital grants to improve the financial feasibility of on-farm improvements to manage run-off, slurry, and other known sources of phosphorus to the lake.

Other programmes of direct relevance to water quality improvements from agriculture include the Single Farm Payment of the European Common Agricultural Policy and associated cross-compliance requirements with environmental standards, and the Rural Development Programme for England which includes the Uplands Entry Level Scheme (UELS) and the Environmental Stewardship Entry and Higher Level Schemes (ELS and HLS). ELS and HLS replace the Environmentally Sensitive Areas scheme (ESA) under which farmers in Loweswater have previously received payments for management which lowers environmental impact. The ELS is a broad and shallow scheme, not tailored to the improvement of high quality areas, whereas HLS allows a more flexible and tailored approach for improvement of high quality areas. The potential for HLS to play a part in improving water quality at Loweswater is referred to later in this chapter.

The LDNPA's statutory responsibility is to conserve and enhance natural beauty, wildlife and cultural heritage, and to promote understanding and enjoyment of the park area by the public whilst also fostering the economic and social well-being of local communities. As such, the condition of Loweswater and the impacts of farming and other land-based activities on water quality are of direct concern to the Authority and its partners. In contrast to previous plans, the Management Plan for the Lake District National Park 2010-15 was produced by twenty-three partnership organizations, which included borough, district and county councils plus organizations such as the EA, National Farmers Union (NFU), the NT and NE. It relates to the park area and not just the Authority itself. The Loweswater Care Project (LCP) is specifically named in the Plan as one of fourteen lake and valley catchment initiatives meant to guide and influence the management of the landscape over the five-year

period. Prior to 2010, there was no explicit acknowledgement in the Management Plan of the water quality issues experienced at Loweswater.

Strategic Activity Number 22 in the 2010-2015 Plan – to improve the quality of surface waters in the National Park - includes aims particularly relevant to the management of land and water at Loweswater. It is to be achieved by undertaking a comprehensive lakes-wide programme of surface water quality improvements, led by the EA. One year action plans and five year business plans are agreed to tackle water quality issues. However, the Plan states that these “will initially be for the priority catchments of Bassenthwaite Lake and Windermere but will seek to cover the whole Lake District in the future”. Thus at the time of the research project it was recognized that it might be a number of years before Loweswater will benefit from this main water quality improvement programme in the Lake District.

The NT takes an active role in promoting a more integrated approach to the management of water, land and related natural resources (National Trust, 2008). Key recommendations include the management of pollution at its source rather than traditional ‘end-of-pipe’ treatments which are expensive and energy intensive. It also argues that “it is time to move away from fragmented land and water management to embrace a new approach that respects natural river catchments and their processes, and considers our impacts upon water along its entire path from source to sea” (National Trust, 2008 p24). To achieve this, the Trust has called on other public and private interests to adopt the same principles. However, targeted action to this effect has not yet been applied to Loweswater.

We note for the record here that both the LDNPA and the NT have policies which could be used to underpin a small amount of investment in Loweswater for potentially very promising environmental quality returns, as well as publicity concerning timely and well-targeted ‘action’. Much of the research needed to underpin such actions has already been done through CEH and the RELU project; monitoring could be continued through the LCP at very little cost; and simple, inexpensive infrastructural improvements could make a significant difference to the amount of phosphorus reaching lake waters.

[b]Getting started

[c]How the Loweswater Care Project started – key events, organisations and people

The research and participatory mechanism described below built on a prior project initiated by a group of approximately ten farmers aimed at tackling the algal bloom problems. It was instigated and led by the late Danny Leck, a local farmer, and called the ‘Loweswater Improvement Group’ (2002/3). Through part-time work with an organisation aiming to help rural businesses after the 2001 Foot and Mouth livestock disease crisis (Rural Futures in Penrith), Danny Leck became aware of potential funding sources that farmers could access to help them address nutrient losses from their farms.

The Loweswater Improvement Group did not arise purely out of concern for the lake, although that was a key motivation. Farmers also wanted to pre-empt interventions by the EA which had recognised that Loweswater was unlikely to reach the water quality standards required by the EU WFD. As a result, the EA had begun to serve notices on a number of

properties instructing them to check and address any problems with their septic tanks. Farmers were aware that their farming practices might also come under scrutiny from the EA and this motivated them to take action.

Another key organisation driving change in the catchment was the NT. Concerns about lake quality in the early 2000s began to sour its relations with local farmers. With the NT keen to ensure that improvements were made, and at the Loweswater Improvement Group's request, the NT provided funding for soil samples to be taken in 2003 and the results were used to advise farmers on fertilizer application.

In 2003/4 the LDNPA, in drawing up a Management Plan for the park, held consultations with a range of stakeholders. Two Loweswater farmers (Danny Leck and Ken Bell) attended one of the meetings and spoke about their actions at Loweswater. This gained the interest of a scientist (Lisa Norton) from CEH and eventually led to work in 2005 to investigate the impact of farming practices on Loweswater funded by NE and the NT (Maberly et al, 2006). Through the period 2003-2007 farmers and locals worked together, sometimes with scientists, to gain funding for practical actions to address the lake's pollution. These included the installation of new septic tanks at several properties at the north end of the lake, the installation of new slurry facilities and a small reed-bed, and new systems for the separation of rainwater and slurry in farm yards.

In 2004 a scoping study⁵ explored the possibility of expanding the farmer-based Loweswater Improvement Group to include other relevant stakeholders and local residents (Waterton et

al, 2006), and in 2007 this expansion formally took place through the initiation of the 2007-2010 project.

[c]Underpinning rationale and leadership

One of the three principal aims of the 2007-2010 project was to create a new ‘social mechanism’ which would comprise researchers, the local community and other relevant stakeholders. The ‘Loweswater Knowledge Collective’, as it was initially called, was envisaged as a way of sharing expertise, collective learning and working together to identify solutions. It would adopt a holistic and catchment-based perspective, and thus would incorporate many of the aims and characteristics of integrated catchment management (ICM). It would also seek to recognise and exploit the benefits of public participation in decision-making, whilst being informed by recent social scientific critique of such processes. More specifically, participatory catchment management has often been criticized in the past for being too agency-centred and expert-led, with other important and legitimate voices often not being given adequate recognition or opportunity to have a meaningful input to actual decisions. In effect, public ‘consultation’ rather than direct participation in decision making has tended to be the norm, although many such initiatives have been presented as ‘participatory’ by their advocates. As such, the LCP was to be set up by the local community, stakeholders and researchers *together* as part of the research project, and structured in such a way that it facilitated: the co-production of knowledge by scientific, institutional and lay persons alike; the opening up of multiple perspectives on the ‘problem’ at hand; and the creation of a social space in which disagreements, the struggle to create new problem definitions, and agonistic debate could take place (Tsouvalis and Waterton,

2012). The 'Lowswater Knowledge Collective' was renamed (in June 2008) by the participants as 'The Lowswater Care Project' (LCP).

From 2007 onwards, the LCP consisted of a heterogeneous group of people. Members were not pre-selected, making this a truly open forum. Between 2008-2010, the LCP met 15 times, roughly every two months, for meetings lasting up to three and a half hours. It typically attracted between 25-35 participants, including 3-6 natural/social scientists from Lancaster University/CEH Lancaster, 2-5 agency representatives from NE, the NT, the LDNPA, the EA, and local residents and farmers among others. The agenda for each meeting was driven by LCP participants, and there was not a single strong 'leader' of the group. Rather, the group worked collectively, generating ideas and future proposals from within. Meetings were initially chaired by Lancaster University/CEH researchers or Ken Bell (a local farmer employed one day per week on the research project as a 'community researcher'). Since January 2011 meetings have been organised and chaired by residents living within the catchment and a LCP Steering Group consisting of 8 people has been established, the majority of whom live in the catchment or locally. Under this volunteer Steering Group, The LCP decided to call itself the Lowswater Care *Programme* (rather than 'Project'), and to become part of the West Cumbria Rivers Trust (WCRT, 2013).

[c]Development of a common vision and setting of goals

Many of those involved in the LCP wanted to avoid problems that had beset other examples of public participation in environmental (and other) decision- making in the past. One such problem is the creation of a 'common vision' at the expense of allowing disagreement and

heterogeneity to thrive in a group of what are, after all, people with very different perspectives. The LCP therefore had to try and balance the sense of reassurance that a bottom-up group derives from having a ‘common vision’ with a sense that dissent, disagreement and thinking differently, or ‘outside of the box’, are important and valued.

A common vision was created through the agreement of a ‘mission statement’ in February 2009, which read:

“The Loweswater Care Project (LCP) is a grassroots organisation made up of local residents, businesses, farmers, ecologists, sociologists, agronomists, environmental agencies and other interested parties. We work collectively to identify and address catchment-level problems in an inclusive and open manner. The LCP’s vision is to gain a better understanding of the diverse challenges faced by the Loweswater catchment and together to seek economically, socially and ecologically viable ways forward and put them into practice”.

This mission statement is intentionally not prescriptive about specific goals that should be achieved and during the process of creating it a lot of emphasis was placed on the need to improve understanding and to allow for dissent, disagreement and the articulation of alternative perspectives. This was something repeatedly emphasised throughout the programme of meetings and upheld by careful and deliberately inclusive chairing and facilitation.

[b]Approach and Tools

[c]Processes of partnership building and co-production of knowledge

The sense of *need* for a partnership was important in shaping the LCP's approach because existing monitoring efforts, organisational and institutional arrangements, and the threat of possible EA penalties were making no palpable difference to the blooming of algae on Loweswater. The new partnership thus *had* to provide an alternative approach to those conventionally adopted in the UK to deal with issues of diffuse pollution. This meant exploring different understandings of the problem, witnessing and incorporating into the research different forms of expertise that might be relevant to the problem, and finding new ways of working together. From 2008 onwards, the LCP started to experiment by thinking critically about the *co-production* of knowledge and action. All forms of existing knowledge and expertise were considered valid, and all were critically questioned, whilst attempts were still made to bring together new forms of knowledge, data, understanding and experience for scrutiny and possible use. Working in this way meant that LCP participants learnt how to appraise critically, in public, many different kinds of knowledge about Loweswater and its social, economic and environment connections (including affective experiences and memories) (Tsouvalis and Waterton, 2012). At each meeting many different forms of new knowledge were brought into the forum of the LCP to be openly questioned, critiqued and 'de-constructed' by those present. The process of partnership building became one of questioning, debate and inquiry that, it was hoped, would lead to collective learning and possible agreement about actions and directions to be taken in the future.

Important to the LCP's way of supporting people and partner organizations to work together was the way in which the group approached 'fact-making' about algae, the lake, the catchment or other relevant 'objects'. The LCP held that, in LCP meetings:

- *understandings of nature are not self-evident;
- *all knowledge and expertise needs to be debated;
- *uncertainties in knowledge need highlighting and accepting;
- *new connections are valuable;
- *doubt and questioning needs to be extended to all the LCP's representations, including scientific representations⁶.

Algae, for example, did not simply feature in the LCP as facts represented by science. Even though the LCP had a professional aquatic ecology team monitoring and modelling the state of blue-green algae in the lake, the LCP debated, agreed, and also disagreed on the issues raised by the 'algae problem'. Scientific data were questioned and debated by all LCP participants. Discussions within the LCP brought more questions and connections to the fore: was the management and maintenance of feeder stream channels, or the maintenance of lake side vegetation, connected to the algal blooms? Did algal blooms impact on fish stocks? Did they deter tourists from coming to Loweswater? Were septic tanks well-functioning or were they relatively neglected, adding to the phosphorus loading of the catchment? Such questions illustrate how the avoidance of framing the algae problem in strictly scientific terms widened the scope within which it could be addressed; it invited a more holistic approach; the water quality problem becoming set within the 'problem' of integrated catchment management.

Becoming interested in many new questions, participants also began to collect samples (the work of participant Andrew Shaw provides an example), to question prior sampling techniques (for example, questions posed by a LCP participant at the LCP Meeting on 28th September 2010 regarding modelling of Loweswater), to monitor different pathways of nutrients (the study carried out by a local resident Leslie Webb), and to undertake their own small-scale research projects (see next section) to help understand the problem (Shaw, 2009; Webb 2010). In the period 2007-2010, most of the collective partnership working that was carried out in the LCP related to ‘finding out more’ about the problem of blue-green algae and the way they interrelated to human and non-human ecologies and systems.

[c]The LCP initiated studies

An innovative aspect of the project was based on recognition of the need for the LCP to have some autonomy. Thus a sum of money was included in the research project award that became available to the LCP during the project to commission its own small-scale research studies. This otherwise unspecified budget of thirty-five thousand pounds was a unique undertaking within a research project of this type. It was considered by the funders to be an important innovation in that it encouraged and empowered lay people to get involved in research and enabled them to contribute to finding out more about the issues that concerned them. It was found to have very positive impacts for the LCP and for the research outcomes as a whole. This innovation also sent a very clear signal that the LCP was a ‘levelling’ mechanism that enabled people from a wide variety of backgrounds and with different forms of expertise to become directly involved in scientific work.

Five studies were funded in this way, two of which were undertaken by local people: a survey of the functioning and use of all septic tanks in the catchment (Webb, 2010); and a study of attitudes to tourism and economic development in the valley (Davies and Clark, 2010). The remaining three studies included: a limnologist (lake scientist) working with a historian to compare a lake sediment sample (physical diatom data) with historical data for land-use change in the catchment (Winchester and Bennion, 2010); an aquatic ecologist working with farmers in the catchment to collect more data to understand how agricultural phosphorus indices related to phosphorus flows in the catchment; and a hydro-geomorphologist carrying out a study of the macro-scale hydrological movements in the catchment (Haycock, 2010).

[c]The importance of trust between partners and how it was developed

In 2007, good relations between the local actors at Loweswater were not widely enjoyed. The owners of the lake (the NT) and the farmers mistrusted each-other, while relations between non-farming local residents and the NT and those between Lancaster University/CEH researchers, local residents and farmers were more variable. Over the period 2007-2010 trust between these different parties grew. In particular, the improvement of relations between local farmers and the NT was hailed as one of the main achievements of the LCP.

In part we attribute this change to the approach that the LCP took to knowledge-making and expertise, an approach that was open and simultaneously critical and reflexive about all

forms of knowledge and expertise employed. Together with the lack of hierarchy designated to individuals, organisations and different sources of knowledge this engendered an inquiring and trusting atmosphere within the LCP.

Another contributory factor to the growing sense of trust between participants observed over this period was the procedures followed in LCP meetings. Meetings typically spanned an entire evening (5.30-9.00 p.m.) beginning with tea and biscuits and time to chat and catch up. Mid-way through the meeting all participants shared a cold buffet together. Again this provided time for informal conversation, making connections, discussion of issues and organization of additional activities or meetings as well as bridge-building among people and organizations that had been in dispute in the past or had little prior contact with each other. LCP meetings consistently attracted good numbers and this made for a congenial atmosphere.

A further factor engendering trust may have been the attention paid to communication. All LCP meetings were advertised through the Parish newsletter distributed to all residents in the Parish. Invitation cards for every forthcoming meeting were sent to everyone that had previously attended or expressed an interest in the LCP, as well as to all households in the Parish. Write ups of past meetings also often featured in the Parish newsletter. Minutes of the meetings were posted on the 'Community Noticeboard' of the research project website.

The continuity and regularity of meetings, adequate communication about meetings, a sense of purpose in bringing new knowledge and new ways of thinking about Loweswater into the

forum, and the way the meetings proceeded in practice, all seemed to help to foster trust between participants.

[c]Processes of stakeholder engagement

As mentioned above, the LCP was *made up*, in part, by institutional representatives, both regular (EA, NE, LDNPA and NT) and occasional attendees (private and public bodies). In order to capitalize on this, and to make explicit the roles and responsibilities of participating institutions, one LCP meeting – proposed by local people taking part in the LCP - was organized around the theme of ‘getting to know your institutions’ (15th July 2009). This involved informal talks by representatives of the key agencies followed by open discussion and a question-and-answer session. This meeting indicated that all of the institutions recognized the importance of integrating land and water management within the catchment area and had begun changing the ways in which they developed and implemented policy in order to reflect this new and more integrated approach. Furthermore, several institutions were already working together to address land and water problems in parts of the Lake District. A sense of enthusiasm and commitment towards working in partnership with local communities was obvious, and this was reflected in the good attendance by institutional representatives at LCP meetings over time.

Nevertheless, it also became clear that obstacles remained that prevented institutions from putting integrated catchment management fully into practice. Each institution operates within different geographical boundaries and at different spatial scales. For example, the EA was organizing its work around the North West River Basin District and the large-scale

catchment areas within it. In contrast, the geographical jurisdiction of the LDNPA is divided into five ‘Distinctive Areas’ that reflect different social, economic and environmental characteristics. The NT manages its land and water assets (including Loweswater) on the basis of the estates which it owns, rather than in relation to catchment areas. Although the ECSFDI operated by NE takes some account of hydrologic boundaries, the priority areas identified for advice and capital grants do not correspond with the geographical boundaries used by any of the other institutions. As such, there was observed to be a fundamental institutional problem of ‘spatial fit’ which was hindering progress towards the implementation of integrated catchment management at a local level.

Interactions with the institutions further indicated how the complexity and uncertainty of water quality issues at Loweswater (often highlighted through LCP critical discussions of ‘the facts’) present challenges to them. Institutions tend to be more accustomed to working on well-defined problems where actions, responsibilities and intended outcomes can be quickly identified. Water quality problems at Loweswater were also perceived as not particularly serious or significant, compared to conditions in other lakes and water bodies in the region (for example, the iconic Bassenthwaite Lake and Windermere). Thus, while institutional representatives were enthusiastic about the LCP and its way of working, some were unsure about how their organization could contribute and link the insights generated through the LCP with their own organization’s decision-making processes and policy priorities. This highlights a key tension in the LCP method: whilst opening up knowledge making to critical scrutiny ensures buy-in for a wide range of participants, helping to maintain a stable, public forum for debate, it may also work to de-stabilize the confidence of agencies in ‘knowing what to do’.

[c]Awareness raising, education and outreach activities

As a forum the LCP evolved organically from its roots in the Loweswater Improvement Project and from the inclinations, intuitions and desires of all those who were helping to form it. As such in the year 2007 it was a forum that was in a delicate state of emergence. Awareness raising, education and outreach beyond its immediate members and stakeholders were not considered relevant at that stage, although the importance of effective communication within the Loweswater catchment itself was recognized. However, by 2010 the LCP had built up more self-understanding, more confidence and more knowledge about its main focus – the blue-green algae on the lake. Using additional end of project funding for knowledge exchange LCP participants in 2010 together created a booklet about how the LCP had developed and what it had achieved to date. The LCP also attracted attention from Radio Cumbria and the BBC's Countryfile programme broadcast a feature about it on 25th September 2011.

So far, the LCP has not engaged in any education activities, but on several occasions, members of the LCP have been invited to present to other groups (e.g. the Coniston and Crake Partnership, the International 'Living Lakes' conference held at Windermere in 2009, the Shropshire Hills Area of Outstanding Natural Beauty (AONB) Partnership, the Lake District's Still Waters Partnership, the Northern Rural Network, and the Government's Commission for Rural Communities). At the end of 2010, a workshop was held in Penrith with national, regional and local policy makers and regulators. The aim of the workshop was to explore the LCP's experiences and achievements with these participants and to probe

their attitudes to participatory and voluntary action. The experience of the LCP has also regularly featured in national knowledge exchange networks and events. The authors also engaged in further funded knowledge exchange activities to translate the LCP's approach to knowledge making and participation to bigger and more complex catchments⁷.

[c]Use of local and expert knowledge

The research project's approach - experimenting with local-level, community catchment management that sought to integrate both natural sciences (land and water) and social sciences - provided the opportunity for original methods of scientific investigation. The small studies described above represented one aspect of this in which a mix of local stakeholders and professional researchers worked together to carry out research. Other aspects of the project similarly demonstrate this collaboration. For example, the formulation and use of modelling approaches incorporated a wide range of expertise from on-site land management considerations to scientific measurement. The rationale here was that increasing local engagement with an issue can help to improve the potential for understanding the causes of the problem through provision of more accurate site-based information. Additionally, the potential for resolving the problem is increased by on-the-ground understanding of possible causes, and through engagement with those who can effect change. Thus the data sources for the modelling included considerable input from local people, right from defining the water catchment, through local measurements of rainfall, to individual management practices for septic tanks. Information about on-farm practices was a key component of the data and was supplied by farmers working with a trusted local advisor alongside the scientists. The use of an agricultural expert to interview

farmers considerably enhanced the quality and depth of data obtained. As anonymity was assured, farmers were also more open about their management practices.

[c]Assessment of land use and farming

Established survey methods (Carey et al, 2007) were employed to measure the ecological and landscape attributes of the land in the catchment by a landscape ecologist from CEH who recorded habitats, landscape features and vegetation across the catchment using a ruggedized computer. This method, whilst labour intensive compared to the use of, for example, earth observation data, was employed to broaden the scope of potential study beyond water quality management (although water quality is the focus of this chapter). An agricultural economic assessment of the catchment was made in collaboration with the farmers by a local farm business advisor who collected data on stocking rates, fertilizer application and other parameters needed to create a farm phosphorus budget, as well as information on farm incomes. Again, whilst the core use of the data was in relation to potential water quality impacts, extra data on farm incomes provided the opportunity to look at other aspects of catchment sustainability.

[c]Aquatic monitoring

A monthly lake monitoring programme, using standard techniques, was carried out over three years. Additionally, after considerable local consultation regarding visual impacts and other concerns, a meteorological station with lake monitoring equipment was installed on a buoy on Loweswater. Data, down-loaded by telemetry, included: temperature profiles, oxygen concentration, temperature, pH, conductivity at surface and depth, and surface

chlorophyll *a*. Data were uploaded to the project web-site and made publicly available. Additional catchment data came from a previous study of inflows to the lake by CEH and from flow data provided for Loweswater and nearby catchments by the EA. Aquatic monitoring also included work on fish populations. Fish research complemented water quality monitoring and modelling exercises and formed an important part of the project because of its known interest to local and other stakeholders (Tsouvalis et al, 2012; Shaw, 2010).

[c]Linking land management and water quality through modelling

Ecological research attempted to understand land management impacts on water quality using linked models. By modelling the catchment it was hoped to understand how nutrient loads in the lake were linked to farm management practices and to algal blooms (Norton et al, 2011).

Terrestrial ecology and farm management data were incorporated into a geographical information system (GIS) enabling land management practices to be linked to the environmental quality of the land. The modelling methodology used a series of linked models to assess phosphorus runoff from the catchment to the lake and its impact on water quality. Outputs from a farm nutrient budget model (PLANET, 2013), fed into a hydrological model (Generalized Watershed Loading Function , GWLF, MapTech, 2013) and nutrient outputs from the hydrological model fed into the algal production model 'PROTECH' (CEH, 2013). In order to parameterize these models fully, alongside the GIS information, land management information from the farmers, meteorological data from the

in-lake buoy and from residents' rainfall gauges, and hydrological data from the catchment (and where lacking from adjacent catchments) were used.

In order to test the validity of the modelling approach the models were run using current data to model nutrient inputs and potential resulting algal concentrations. Data from the automatic monitoring buoy was used to validate the results. In addition, four scenarios were explored to reflect alternative land management options and to provide information about how changes in management practices may potentially impact on nutrient inputs and algal concentrations. Non-farming scenarios included a wooded (deciduous) catchment ('woodland' scenario), and a no-input grassland scenario without livestock ('natural grassland'). Farming scenarios included: 'no cattle, double sheep numbers' and 'double cattle, half sheep numbers' representing potential, though extreme, changes in the livestock composition of the catchment. Nutrient loads from septic tanks (from the LCP study by Webb, 2010) were input to the GWLF model in two ways: as a diffuse source of nutrients where phosphorus discharge from septic tanks was incorporated into the farm nutrient budget in the same way as other sources of nutrients; and as a point source of nutrients where effluent was assumed to discharge directly to the watercourse, i.e. a worst case scenario. The models, as presented to the community, made it clear that the presence of people and livestock in the catchment comes at a cost to lake water quality, but that the cost may be minimized by improvements in nutrient management.

[c]Science communication

All of the scientific investigation carried out during the project was reflected back to LCP meetings. This could include quite complex issues, particularly in relation to the modelling, and scientists worked hard to make their science as transparent and understandable as possible. This was facilitated by the prior processes of engaging the LCP participants in data collection and assembly for the modelling, and in assessing the provisional results of component models (land, farming and aquatic). This all helped to make the modelling more than just an abstract exercise, and was critical, as acceptance of the legitimacy of the modelling approach was essential for its use by the LCP in informing deliberation and decision making. The models provided information to the community, and where relevant an individual farmer, helping to highlight the impacts of septic tank and farm management on water quality. Behavioral change in response to the information provided by the models was not formally measured but we do know that the farmer whose practices appeared to be resulting in excess nutrient loss addressed the issue and that community awareness regarding septic tank management was heightened.

[c]Monitoring

Much of the detailed water quality monitoring carried out by CEH depended on the research project funding from 2007-2010 and thus could not continue indefinitely. Monitoring that is continuing is the CEH 'Lakes Tour' that takes place seasonally every five years (Maberly et al, 2011). Local residents have carried out voluntary water quality monitoring since 2011. The EA also take measures of Loweswaters' 'in' and 'out' flows and this will contribute to this dataset if continued on a regular basis. On-going rainfall measurements in the catchment provide accurate data which can help in understanding nutrient pulses to the lake (subject to the availability of temporally consistent data on lake nutrients). In addition, a local resident

is continuing phytoplankton counts to supplement the EA monthly chemistry analysis. Continued monitoring of farm nutrient inputs and losses will depend on funding for soil sampling and farmers' use of nutrient budgeting tools. Whilst the ECSFI catchments have provided courses for farmers to learn how to use farm nutrient budget models, this training has not yet been made available to farmers outside of those catchments. Similarly there is no funding available for farmers to have soils analyzed regularly, although potential savings in fertilizer applications do provide some incentive for this. Adequate and cost effective monitoring will be important to the future activities of the LCP but it remains to be seen how this can best develop.

[b]Getting Things Done

[c]Evolution of the initial organizational and institutional structures into an operational phase

The LCP remains a community-based and bottom-up organization, which since January 2010 has been organized and facilitated purely from within the catchment. For example, the Loweswater farmer who was employed one day a week from 2007-2010 as a 'community researcher' in the research project remains involved, and became a member of the LCP Steering Group. After its formation the Steering Group aimed to act upon the 'knowledge base' generated during the 2007-2010 project to continue to gather evidence as a basis for decisions and action, and to explore practical ways to improve the condition of the lake. They obtained a grant from the Catchment Restoration Fund of the Department of Environment, Food and Rural Affairs (Defra) and decided to become part of the West

Cumbria Rivers Trust (a charity). This ensured that further collective work would be financially supported for the following few years at least. Further funding for farm infrastructural works through the ECSFDI has enabled at least one Loweswater farmer to re-organise the storage and disposal of animal waste on the farm site.

As a minimum, a clear and valuable function for the LCP has been to provide a forum in which controversial issues can be aired, opened up, worked upon collectively, and critically examined. The possibility of doing this encourages good and trusting relationships, enabling issues to be resolved promptly and efficiently. However, whilst many members of the community are actively working to improve water quality through the LCP, others in the catchment are not fully engaged with the process and it may be that regulatory compliance is necessary to effect changes in those cases (unless those individuals can be drawn into the LCP more effectively). The LCP is a forum in which it can be recognized that additional action may be required from the regulatory authorities also. The trust that has been built up between parties in the development of the LCP is a valuable asset, and remains vital for the future of the LCP.

[b]Outcomes

[c]Measures of success: outcome and process indicators

The LCP mission statement above sets out some long-term ambitions but the two most obvious indicators of its effectiveness are: successful community and stakeholder engagement, and a lake with good water quality. We give some details of these below but

we note first also that the former may appear to have been relatively quickly achieved and quantifiable, although in practice long-term continued engagement is what is required and this is not guaranteed. The latter may also take a long time to achieve. There are some good indications in very recent lake monitoring data (see Bell et al, 2011) but there may be few interim indicators of progress because of changes in land management and other behaviour that are still required, and because of the potential lags in the response of the lake (e.g. to declining phosphorus inputs), as the natural system includes phosphorus ‘recycling’ from sediments in the bottom of the lake, amongst other complex ecological factors.

In terms of stakeholder engagement it is possible to gauge the level of involvement and interest through the number of organisations and individuals attending and contributing to meetings. The degree to which communication has improved between members of the group is also important. This may be measured in terms of the production of group outputs and joint decision-making. In this case outputs include: a mission statement, planning documents, funding decisions for the small research projects and actions taken by the group or individuals within the group. At Loweswater a number of group actions preceded the LCP, including action by the farmers to set aside land adjacent to the lake from intense livestock production, and sourcing of co-funding to improve slurry holdings, separate waste water from rainfall on particular farms and replace septic tanks on private and commercial properties. Under the LCP itself, achievements in terms of engagement include the stakeholder meetings, and improved relations between the National Trust and farmers leading to joint decision-making about the management of the lake outflow and alterations to farming practices resulting from the outputs of the lake modelling exercise. The ‘foundations’ have been laid for continued group activity, improved individual awareness

for management and maintenance of septic tanks, and regular soil testing for more optimal nutrient management on farmland. From 2012 further work and actions were supported by the West Cumbria Rivers Trust and grant from Defra.

In terms of lake water quality, monitoring by CEH has proved invaluable in providing information on changes in lake water quality, and only continued monitoring can enable the LCP to judge whether it is achieving its aims in future. As mentioned above, the data gathered to the end of 2010 was beginning to show a slight improvement in terms of total available phosphorus within the lake compared to the early 2000s; in 2008-2010, annual concentrations of phosphorus and phytoplankton chlorophyll (a measure of abundance) were lower and the oxygen concentration at a depth of 6–8 m was slightly higher (Bell et al, 2011). It is known that lake recovery may be a lengthy process given the unquantifiable nutrient loading still arising from lake sediments. It will be essential to maintain and enhance the knowledge base concerning the physical processes involved, and to continue to involve stakeholders in dialogue about these issues to support their motivation.

[c]Socio-economic impacts

Social and economic changes within the catchment are central to the concerns of the LCP and included in its mission statement, and there are certainly expectations that the LCP can have impact through working with those agencies responsible for social and economic development. Data about socio-economic aspects of the catchment has been collected both as part of the research project and by the LCP itself through one of the small research studies that was concerned with tourism (Davies and Clark, 2010). A key socio-economic

issue in the Loweswater catchment is the low level of farm incomes, such that farmers see the need to ‘maximize’ productivity of their land and herds, with potential impact, in turn, on land and water quality. The LCP provided a forum in which this was set against the many positive impacts that farmers have on their environment and the social structure in the catchment. Whilst this did not result in a change to the situation to date, broader awareness of the issues amongst the wider community and agencies involved in the catchment has been a positive outcome.

[c]Sustaining the LCP

To date, the LCP has been very well supported by the various statutory bodies mentioned above. Participants of the LCP seem to be keen to maintain the group and have decided that it should continue under the auspices of the West Cumbria Rivers Trust. The Catchment Restoration Fund grant of more than £300,000 will ensure that the LCP can continue to set its own goals and try to meet them into the future. Further funding may also be sought involving the entry of farmers into a group agri-environment scheme agreement (HLS) when current (ESA) agreements expire. This potential was explored with the assistance of NE as part of the research. The Higher Level Scheme would help to assist continued improvements in the catchment that will impact on lake water quality whilst providing farmers with a better income than available under the Entry Level Scheme.

There are further questions about whether the LCP should remain an independent group or link with other initiatives, for example, the Melbreak Communities, a community programme comprising four parishes including Loweswater, which is currently host to LCP

web-based information. Other options are to further link with other Rivers Trusts (for example, the Coniston and Crake Partnership and Eden Rivers Trust, and Rivers Meet in Cockermouth). Further possibilities include a whole valley farmers' group or a group consisting of farmers, business representatives and agency representatives (such as already exists in Patterdale, Cumbria).

[b]Concluding reflections

[c]Achievements

Three key achievements are considered to stand out from the experience the LCP:

I doing science together and using other forms of knowledge-making to lead co-inquiries and to co-research new issues (co-production of knowledge).

The LCP was a deliberately reflexive organization, bringing together knowledge and action, but also critically questioning the procedures and tools enabling it to learn, and the knowledge and actions being produced (Rabeharisoa and Callon, 2004). In practice, this meant that items brought to the LCP for discussion were heavily scrutinized and never taken as self-evident. Uncertainties and ignorance were often highlighted, as was the need to make decisions in the face of such conditions rather than delaying actions in the hope that things will become more certain in the future. This led to many fascinating discussions and indicated areas for further research. The five small studies described above had all been generated within the forum of the LCP. They created new collaborations between local people and University and CEH researchers, thus breaking down barriers between 'science' and 'society' in very practical ways. LCP participants were therefore all involved in one way or another in the co-production of knowledge that was considered useful in

understanding the problem(s) at hand. We consider this spirit of inquiry, and the level of sophisticated questioning and critique that accompanied it in the LCP meetings, to be a key achievement of this forum.

2 Opening up multiple perspectives on the issue or problem at hand, and refusing to allow an overly reductionist framing of 'the problem' when participants see the relevance of multiple framings or connected problem definitions.

“Well I mean if we have a dead lake we’ve got a dead community because it’s not just the farming you know, we’ve got a camping barn, hotels, tourism. [...] There’s a lot of other income comes into the valley rather than just the farming now”. (Interview with Loweswater Resident, 2008).

As the quote above illustrates, many things in Loweswater depend on the environmental health of the lake, and one commitment of the LCP was to encourage participants to contest any particular framing of the issue of blue-green algae on Loweswater. This opened a space for them to articulate what Wynne calls a ‘societal definition’ of the issues of public concern, rather than imposing a scientific definition of ‘*the problem*’ from the top down and from the outset (Wynne, 2007, p108). In practice, this meant that public definitions of ‘the problem(s)’ were encouraged and questions as to what is relevant to the issue of blue-green algae in Loweswater remained open. This led to the consideration of a wide range of connecting issues including: farm livelihoods and farming futures in the Cumbrian uplands; the changing policies of the National Park and Natural England and the way these affect places like Loweswater; household detergents and the possibility of a catchment-wide

change to low phosphorus dishwasher tablets; the effects of algal blooms on tourist visits; the sensitivity of food-chains and the aquatic ecology of Loweswater.

Taking a very open view of what is relevant in thinking about environmental quality and environment-society interactions in Loweswater allowed an ecological, scientific, and regulatory framing of the blue-green algae problem to connect to other framings (economic, sociological, cultural, even philosophical). This led to a cycle within the LCP meetings which moved from the algal problem to wider catchment issues and back again, an intellectual ‘opening up and closing down’ (Stirling, 2005, p218) that over time began to characterize the ‘rhythm’ of the LCP.

3 Creating a forum in which contestation, disagreement and agonistic struggle to define issues and problems can legitimately take place.

One of the most significant concerns found in critiques of stakeholder participation is the idea that participation often consists of little more than a public relations exercise designed to persuade and mollify the public, and to gain their support for previously identified ‘expert’ discourses, rather than let that public inspire alternative ways of thinking. In contrast a third strength of the LCP has been the way that it encourages different voices to be heard, alternative perspectives to be offered, and disagreements and conflicts to be aired (see Tsouvalis and Waterton, 2012 for an account of such ‘agonistic’ practices). This commitment to encouraging diverse and conflicting perspectives to be articulated meant that, in the long-run, it became possible for all in the LCP to consider some of the inequities and imbalances that exist in Loweswater. For example, the reality that Loweswater is a

place characterised by increasingly elite consumption. It is no longer a predominantly productive landscape but one that is consumed, by Lake District tourists and wealthy retirees. There exists, in fact, very little economic opportunity in the catchment for those who are not retirees or farmers. By exploring this, LCP participants have been able to appreciate, for example, that farm households making a marginal living from sheep and beef farming have, in the past, been too readily blamed for spoiling a picture-perfect Lake District scene, through their supposedly over-zealous farming practices. Through the LCP, and particularly through the representation of local farmers in meetings and the encouragement of farmers to say their piece, participants have become more interested in understanding farming trends and practices to try and find ways of ameliorating phosphorus flows from farm holdings to the lake, without attaching blame or finger-pointing.

[c]Weaknesses, continuing challenges and some lessons from failures

The ‘openness’ of the LCP to problem-definition as described above might be perceived by some as a weakness, not least for those used to more conventional scientific approaches to catchment management. Occasionally, it led to outbursts of frustration as, for example, when a participant would suggest that the group, as a whole, had ‘lost focus’ on blue-green algae whilst pursuing these other connections. On other occasions participants would acknowledge that it was impossible to think about the algae ‘in isolation’. The connections made and their relevance seemed to be increasingly appreciated over time, as a more complex and composite picture of Loweswater and its algae began to emerge through investigations and discussions played out through the LCP.

The LCP experience has also shown that doing science with the public and fostering trusting relations between scientists, farmers, institutional stakeholders and the public is a time-consuming and long-term commitment. It involves a considerable investment of time in ‘finding out’ what the issues of concern are, how they are connected, and how they might best be addressed and by whom. Again this is not a direct weakness as such but it can slow down diagnosis and action. On the other hand, if a problem is only narrowly defined and action is imposed quickly, the solution may not find acceptance amongst the community or prove misdirected. It might even exacerbate a ‘problem’ that is poorly understood.

Continuing challenges include defining catchment improvement actions, and to strengthen the partnerships needed for many actions. The latter raises the question as to whether the LCP can convince relevant institutions to prioritize Loweswater; and for the institutions it raises the question as to whether they will be able to adapt their often larger scale focus and systematized programmes to the specific needs of this small catchment. A further challenge extends beyond Loweswater. Despite Loweswater’s small scale and relative simplicity as a catchment, the authors think that knowledge of the way that that participation and science were effectively integrated in local catchment management through the LCP could possibly be used to improve the way the EU WFD is being implemented. Further knowledge exchange activity in 2012 explored these and other issues, producing some simple recommendations from the Loweswater project for future catchment management projects (Waterton et al, 2012).

[b]Notes

1. The project was funded by the Rural Economy and Land Use (RELU) programme of the Economic and Social Research Council (ESRC), the Biotechnology and Biological Sciences Research Council (BBSRC) and the Natural Environment Research Council (NERC), with additional funding provided by the Scottish Government and the Department for Environment, Food and Rural Affairs.
2. A map and further information can be viewed from the website of the West Cumbria Rivers Trust (<http://westcumbriariverstrust.org/areas>).
3. The Environment Agency is an Executive Non-departmental Public Body responsible to the Secretary of State for Environment, Food and Rural Affairs in England and a Welsh Government Sponsored Body responsible to the Minister for Environment and Sustainable Development in Wales. Its principal aims are to protect and improve the environment, and to promote sustainable development, and it is empowered by law as the main regulator of discharges to air, water, and land.
4. Natural England is an Executive Non-departmental Public Body responsible to the Secretary of State for Environment, Food and Rural Affairs. Its purpose is to protect and improve England's natural environment and encourage people to enjoy and get involved in their surroundings.
5. Also RELU funded.
6. These commitments to questioning were derived from the work of Latour (2004).
7. A project funded under the NERC's Water Security Knowledge Exchange Programme: 'Understanding and Acting in Loweswater: A community approach to catchment management', January-April 2012.

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