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LONG-TERM BENEFITS AND PERFORMANCE OF DAMS

Chapter 1. Benefits and social impacts of reservoirs

The benefit of dams to society

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SYNOPSIS. Dams have been constructed from historical times to provide the needs of many civilisations. Focussing primarily on the UK, the paper sets out the benefits of improved health and life from the provision of a clean water supply from reservoirs, protection from drowning and damage from floods, the provision of power from hydro schemes, water for irrigation, as well as the recreation and environmental benefits of the reservoirs.

INTRODUCTION

At the launch of the World Commission on Dams Report, Nelson Mandela said that for all the problems around some dams; "the problem is not the dams. It is the hunger, It is the thirst. It is the darkness of a township. It is the townships and rural huts without running water, lights, or sanitation." (Bridle 2003). How true. This paper looks at the benefits of dams, and the problems that society would face without them, concentrating primarily on the UK but with illustrations from other countries.

Dams provide water for society to drink and use, protection from both river and marine floods, hydro electric power, irrigation water to grow food, a pleasant recreation area, and enhanced environment. Dams have been constructed during different periods depending on the needs of society at the time.

EARLY DAMS

Dams have been reported from earliest historical times such as the Maan Dam which provided water for irrigation and water supply for the Queen of Sheba's people.

Some of the oldest small reservoirs in UK were constructed by the medieval monasteries to provide supplies of fish, generally carp. The provision of fresh food over a longer season must have been of nutritional benefit in those times.

Long-term benefits and performance of dams. Thomas Telford, London, 2004

LONG-TERM BENEFITS AND PERFORMANCE OF DAMS

MILL DAMS

The Doomsday Book, compiled in 1086, included some 7,000 mills in Britain,(Binnie G.M.1987) Many of these would have used a low dam to control water flow in the mill leat and the stream. During medieval times these were used to generate power for flour milling and later for fulling wool. Few mill dams survive today.

The Wealden iron industry, boomed between about 1540 and 1640 using water power to drive bellows to generate heat, to drive the hammer mills that were used to form the iron and to bore cannon (Binnie G.M. 1987). A few hammer ponds survive today.

From about 1750 blast furnaces powered by coal along with water powered hammer mills were developed in Shropshire. Water power was also used to power the spinning and textile mills. Because of the high rainfall these were located on each side of the Pennines (Binnie G.M.1987).

Thus water power from dams and rivers provided the beginnings of manufacturing that led to the industrial revolution and Britain becoming a major exporting nation and the ensuing wealth.

ORNAMENTAL LAKES

The industrial revolution resulted in uncontrolled development, often with unsanitary housing conditions, so the wealthy classes sought separation by constructing large houses and elaborate gardens, often with ornamental lakes. The leading exponent of this was Lancelot "Capability" Brown. Examples today include Stowe, Sheffield Park in Sussex and Stourhead created by Henry Hoare (Binnie G.M. 1987). Many of these are now run by the National Trust and give pleasure to hundreds of thousands of visitors each year.

CANAL DAMS

With the start of the industrial era, based initially on water power, and the opening of the coal mines, a means of transport for coal, iron ore and heavy goods was required. The roads were frequently poorly maintained, rutted tracks and not suitable for transporting heavy loads, particularly coal. Between 1770 and 1830 over 2,000 km of canals were constructed. Water is required for locking and so reservoirs were constructed to provide water to the summit pounds of almost all canals.

As an example of the benefit that canals and their reservoirs can bring, Birmingham, while near to coal and iron mines, was too far from them to be served by the then roads. A ring of canals was constructed both to bring in

raw materials and also to carry manufactured products to London and other ports. This enabled Birmingham industry to flourish.

Without reservoirs canals could only have been built in the lower reaches of a valley where the natural flow in the river was sufficiently in excess of that needed by the mill owners and other users to allow enough for canal locking. Without reservoirs the canal network would have been inadequate for more than local transport, there would have been no link between Yorkshire industry and the important port of Liverpool, Birmingham would have been virtually land locked, and there would have been no inland route to deliver coal to London: see Figure 1 (Dutton 2003). This would have seriously restricted and delayed the industrial revolution on which the wealth of our country was based.

Figure 1: Canal system with no reservoirs.

The canals are now used mainly for recreation with many canal barges being used for sedate leisure, and canal banks providing solitude for anglers often close to urban environments.

In addition water side property in urban areas now provides desirable views and features so these canal areas have attracted redevelopment in such places as Birmingham, Manchester, the Little Venice area of London, and in Leeds.

Thus, over 200 years after their construction, the reservoirs that enabled the canals to be viable continue to serve society.

Dams and reservoirs also support canals in other countries. Probably of most note are the dams at the south end of the Panama Canal which stored water and raised the canal to the extent that its construction could eventually be completed. Without them it would not have been, certainly for many decades later, thus restricting the development and naval defence of the Unites States.

DOMESTIC WATER SUPPLY

As the industrial revolution developed it resulted in much overcrowding and squalor in the expanding industrial cities. Reformers, in particular Edwin Chadwick, realised that conditions, and therefore the health of the people, would be improved by the provision of a clean water supply and the disposal of sewage (Binnie GM 1981). Following Chadwick's report in 1842 (Chadwick 1842), the Public Health Act of 1848 provided, through the Central Board of Health, the means to support towns and cities in providing water supply and sewerage. The health benefits of the wholesome, generally upland, water supplies are illustrated by cholera statistics. In 1832 there were 30,000 deaths from cholera and in 1849 60,000. Deaths continued in the large cities. In 1857 John Snow published his paper on the Broad Street pump episode, demonstrating that infection occurred not from the supposed miasma in the air but from sewage contaminated well water. It was then realised that almost all the rivers in and downstream of urban areas were also polluted both from the sewers and from the filth from the generally unpaved streets.

Steam pumping was expensive so most new water supplies were provided by gravity from reservoirs constructed in upland areas. Because the need for clean water was understood but the methods of water treatment were known to have little effect, most reservoirs had any sources of pollution, such as people and cattle, removed from the catchment area (Binnie C 1995).

The City fathers were not entirely altruistic in improving the health of the industrial workers. Their output increased as well.

The large towns then started to construct upstream reservoirs, Manchester in 1848, Liverpool in 1852 and London in about 1870. The benefit of clean water supplies can be seen in the graph of Enteric deaths in Figure 2, (Binnie C 1995).

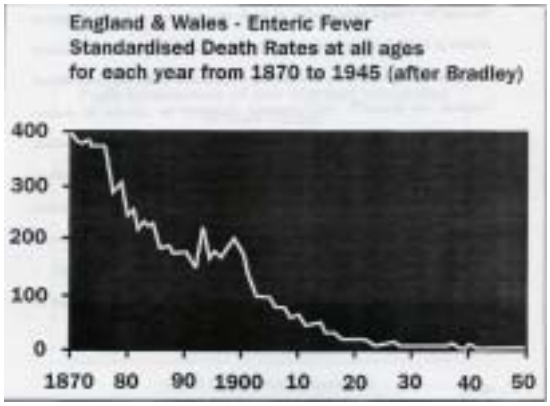

Figure 2: Enteric Fever standardised death rates

There were factories driven by water power downstream of many of the new reservoirs. The mill owners were powerful and demanded that a steady release of water be made, generally amounting to one third of the yield of the reservoir. Today the mills are long closed but this compensation water flow continues providing the benefit of a healthy river environment all year.

It is interesting to consider what the sustainable population would have been without reservoirs. We today use much more water per person than people did in the late Victorian era when reservoirs were first being built. However steam pumping then was both inefficient and costly so long distance transfer of water then would have been impractical.

Taking the instance of Greater London the population in 1870 when reservoirs started to be built was about 4 million. Today the water supplied to Greater London is about 2,200 Mld (Arkell 2003). The river Thames already goes below its minimum environmental flow and the amount available from groundwater is about 200 Mld. Allowing conjunctive use to double this amount would mean, without reservoirs, a population limitation of about 20 percent of the current, or about one and a half million. My great grandfather submitted a Bill to Parliament to bring water by gravity pipeline from Llangorst in Wales to London. However without the benefit of storage the sustainable dry weather flow of the Welsh uplands would have been

low. Until the development of desalination plants during the 1960's London's population would have been severely constrained.

Looking at England and Wales as a whole, the total water supplied today is about 15,000 Mld (Water Facts 2000). The total groundwater abstraction licensed is 8,476 Mld. The Environment Agency consider that about 1,000 Mld of this is over licensed and unsustainable. On the other hand it considers that about 1,000 Mld of river flow could be abstracted during dry weather (Watts 2003). Conjunctive use could increase the amount of water available. However, it can be seen that, without reservoirs, the total population of the country would have been appreciably constrained until the first economic electric pumps became available for long distance transfer, and then the advent of desalination systems.

HYDRO AND TIDAL POWER

After the 1939 – 1945 War the nationalisation of the power industry facilitated a major initiative to develop the hydropower potential offered by the terrain and water in the Highlands of Scotland (Bridle and Sims 1999). Governments throughout the world have used hydropower development to create employment, not only on the project itself, but through a Keynesian multiplier affecting other industries attracted by the energy. The British Government is no exception and the development of hydropower in Scotland was motivated to some extent in this way. By 1980 the hydropower installed in the North of Scotland was 1756MW with an annual output of over 3,000 GWh.

In the North of Scotland over 2,400 km of transmission circuits were constructed. The development of hydropower opened up the Highlands. The construction of a wide transmission system enabled industries to prosper and provide skilled jobs, thereby retaining young people in the Highlands and sustaining a society there with a complete cross section of jobs and income levels. Hydro-production funded the spread of transmission capacity into the glens and farms started to be connected to electricity for the first time. This brought them electric lighting, a fundamental improvement in a region where the winter nights are long, and once the farmers became familiar with the benefits of electricity, they started to use it for milking and to develop their output in other ways. By 1980, 94% of all farms in the neighbourhood were connected and were using a total of 241 MWh. The construction of the dams and power stations also required the construction of new high quality access roads which in turn provided much improved access and in turn brought in tourism.

The problem with nuclear and coal fired power stations was that they were unable to respond to rapid fluctuations of power demand such as when a

system tripped as occurred in 2003 in the eastern United States or when popular sporting events had half time or finished such as the 2003 Rugby World Cup. To respond to this pumped storage schemes were constructed in Wales with a high and low reservoir. The first, the 360MW Ffestiniog scheme was completed in 1964 and the second, the 1800 MW Dinorwig scheme, in 1981. Dinorwig can be brought to full generating load in 12 seconds and is also used to control the frequency of the national grid system. Constructing dams, particularly the 70m high Marchlyn Dam within the Snowdonia National Park, was a challenge but the schemes are now major tourist attractions.

Dams can also be formed in the sea where the tidal range is high and thus generate tidal power. There are several tide mills dating from medieval times and the Carew mill in Pembrokeshire is still in operation today. The 230MW La Rance scheme in Brittany was constructed in the mid 1960s and is the largest in operation.

The English Stones Barrage near the Severn Bridge could develop about 970 MW. (Binnie C.J.A. and Roe 1986) The Severn Barrage lower down the Bristol Channel between Lavenock Point and Brean Down could have an installed power of 7,2000MW, and annual energy output of 14.4 TWh. (STPG 1986). Taylor (1998) estimated this could provide up to 7% of the demand of England and Wales without the emission of polluting gases or the generation of toxic waste products.

Hydropower could contribute much to the UK's efforts in meeting the objectives of the Rio and Kyoto Conferences in reducing green house gas emissions to minimise the impact of climate change. Each kilowatt-hour generated by hydropower saves about 900 grams of carbon dioxide when compared to coal generated power. The hydropower generated between 1947 and 1980 therefore saved a total of 62 million tonnes of carbon dioxide in the atmosphere. (Bridle and Sims 1999)

Internationally hydropower is the world's main source of renewable energy providing about 20% of the world's energy generation. (British Hydropower Association 2003.) Installed capacity is 674,000MW with a further 103,000MW under construction. Dams are required to provide almost all of this.

FLOOD PROTECTION FROM RIVER FLOODING

Dams provide the benefit of protection from flooding from rivers in two ways, either by direct protection or by routing the flood through a reservoir provided for other means thus reducing the peak flow in the river downstream of it.

Examples of the former include many of the dykes through Holland. A good example of the latter in this country is the Leigh Barrier which protects Tonbridge. Without the benefit of the barrier, Tonbridge would have suffered severely in the Autumn 2000 floods.

Nowadays the Environment Agency insist that new development does not increase flooding downstream and that storage be provided. This can either be achieved by excavation of compensation storage but more often by the construction of a dam and empty reservoir. Flood defence reservoirs are often used as amenity areas or used for grazing or other agricultural purposes. Thus dams provide the benefit of being able to carry out development without the risk of increased flooding downstream.

The experience of Dublin described by Mangan (1996) is typical of the contribution by dams to flood relief in the British Isles. Huarricane Charlie produced intense rainfall and flooding on 25th and 26th August 1986. Twenty four hour rainfall in excess of 200 mm was recorded in the Dublin Mountains. The peak inflow to the Pollaphuca Reservoir, at the top of the cascade of the dams in the Liffey valley was 445m^3/s. No flooding was experienced in Dublin. A hydrological model simulating the flow in the Liffey at Dublin without the retention provided by the reservoirs suggests a flow there of 380m^3/s, which would have caused considerable damage in the city.

Severn Trent Water have formalised its agreements with the Environment Agency to hold its Derwent Valley reservoirs at 80% of capacity from October to the end of January better to provide flood reduction downstream. This is typical of arrangements made by other owners of large reservoirs (Bridle and Sims 1999).

Similar features occur overseas. The Yangtze River in China has drowned about 300,000 people in the last century, displaced several million and in 1954 alone inundated 3 million hectares. The Three Gorges Dam will provide flood protection to the 15 million people who now live in the flood plain, converting what used to be a flood every 10 years into one in one hundred years, and to 1 in 1000 years when the Dongting Lakes downstream have been rehabilitated to store flood waters.

SEA DEFENCE

Whilst almost all of Britain is above sea level, there are areas along the coast which have been reclaimed from the sea to provide agricultural or development land. This has been achieved by constructing dams, called sea defences, to keep out the sea. A good example is the sea defences in the Wash to protect the highly productive Fens from being inundated. These sea

defences have resulted in a significant increase in national agricultural output. Some of these are now several metres below high water. A good example of the protection of development is Canvey Island. These sea defences have provided extra land for housing and industrial development particularly for installations needing connection to the sea such as refineries.

Several of the estuaries were developed as ports and centres of commerce. With the south east of England falling relative to sea levels, several of these estuaries here are at risk of higher relative tidal levels. In 1953 a surge tide came down the North Sea and breached the sea defences. This caused 300 deaths in East Anglia but 3000 deaths in Holland. In England this resulted in the raising of the tidal defences and the construction of the Thames Barrier (Gilbert and Horner 1985). Figure 3 shows the area of London provided with protection by these dams (NCE 2003). About one and a half million people work in this area. The 1953 event was lucky for central London in one aspect, at the last moment the extreme meteorological condition curved away and struck Holland instead. Had it not parts of London would have flooded. The benefit of raised river walls and a new barrage provides protection for London against a one in 1,000 year marine flooding event. In 2002 the barrier was shut for 30 tides to prevent either marine or fluvial flooding demonstrating the increasing benefit obtained by this dam system.

Figure 3: Thames flood zone

IRRIGATION

Most supermarkets have strict requirements for quality and size of vegetables and generally require any producer from whom they buy to have irrigation to ensure uniform quality and security of supply.

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Since the Environment Agency no longer allow new summer water abstraction in most of the south, east and Midlands of England, farmers have had to construct on farm storage reservoirs. Thus much of the commercial vegetable crops produced in Britain rely on irrigation water from farm reservoirs.

Overseas weather requirements are often more extreme. Irrigation water is often required to cover an entire dry season. In 1877 when a low Nile flood failed to irrigate adequately, there was famine and death among the six and a half million Egyptian population. In 1902 the Aswan Dam was constructed to provide two crops a year and the Aswan High Dam constructed in the 1960s extended this to provide perennial irrigation for a much larger area and a much larger population as well as 12,000 MW of hydropower. Now Egypt supports a population of over 70 million. Without these dams Egypt's population would have been much smaller than it is today.

RECREATION, CONSERVATION AND ENVIRONMENT

When Victorians built reservoirs they knew they could not treat the water so access to the reservoir, and often to the whole catchment, was often severely restricted. Now many reservoirs are recognised for their recreation, conservation and environmental benefits

On the environment, almost all reservoirs release water downstream thus ensuring the downstream environment is maintained even in a drought. At Roadford freshets are released to mimic the natural river and bring salmon up to the spawning beds. That facility would have been most welcome on many rivers during the drought of 2003.

Many reservoirs constructed on ordinary farmland are now Sites of Special Scientific Interest. Nine reservoirs are now internationally registered under the Ramsar Convention (1971) as "Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention Bureau 1999). One of them (Abberton) is cited as *"…a roost for the local estuarine population of wildfowl. It is outstandingly important as an autumn arrival point, moulting and wintering locality for wildfowl. Thirteen species of waterfowl occur in nationally important numbers, including Widgeon, whose winter numbers are of international significance, Mute Swan, Gadwall, Shoveler, Pochard, Tufted Duck, Goldeneye, Goosander and Coot"*.

All new reservoirs are landscaped. This includes forming fillets and adjusting the slopes of the dams to minimise its apparent height, forming artificial islands so that birds can nest free from the predation of foxes, and forming lagoons along the foreshore to maintain shallow wetlands for

wildfowl even during drawdown. Many now have woodland plantations near the margin. Extensive planting often screens car parks and facilities.

Rutland Water, one of the largest reservoirs in the Britain, is, in the words of Sir David Attenborough, *"one of the finest examples of creative conservation in Great Britain"* (Anglian Water, 1995).

Like most reservoirs it is now stocked with fish. As a result otters and ospreys have been encouraged to breed there, increasing the bio-diversity.

Reservoirs are now extensively utilised for recreation. Most have fishing. Many have sailing clubs. Several have peripheral paths for walkers, bicyclists, and sometimes horse riders. Many have quiet environmental areas where bird watching hides allow visitors to watch many species of birds. Rutland Water attracts 50,000 birdwatchers a year.

Some reservoirs such as Kielder and Carsington commercialise these features with large carparking areas, a large visitor centre, and even caravan parks and chalets. Visitors to Carsington each year are about 1.2 million, to Kielder 1 million, and to Rutland between ¾ and 1 million.

Thus our reservoirs now provide the benefit of good, albeit changed, environment, and extensive recreation facilities.

SUMMARY

In summary, dams and the reservoirs they form, have provided considerable benefit to society from early times providing water for drinking, growing food, and power when it would not otherwise be available. They also provide an enhanced environment and recreation for many. Without dams and reservoirs the industrial revolution on which our wealth was based would have been much delayed. The population of our major towns would have been curtailed. Without hydropower green house gas emissions would have been greater, and hence climate change would have increased. Without reservoirs providing irrigation water more of our food would be imported. However society will only support more reservoirs provided the benefits they can bring are both provided to the full and publicised.

ACKNOWLEDGEMENTS

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Lake Hood - Creating Waves in the Community

G. A. LOVELL, Tonkin & Taylor Ltd, Christchurch, New Zealand

SYNOPSIS. Lake Hood is the largest artificial recreational lake in New Zealand. Located in the South Island of New Zealand, 100km south of Christchurch it services the Ashburton district, which has a population of 30,000 people. The lake area is just over 70 hectares with approximately 7000 m of shoreline and was developed principally for water sport activities. It provides for an international length-rowing course (2km), as well as water skiing, sailing, dive training, swimming and sunbathing. As part of the development of the lake a new residential subdivision on its shores has been planned. This includes a staged construction of 150 sections with lake or canal frontages.

From its initial conception the social impact of the lake's construction on both the township and its surrounding population was considered. Throughout this innovative project the close liaison with the local community, through public meetings, public open days and transparent media coverage has meant that support has grown in parallel to this community spirit. The community resource has impacted, both socially and commercially, on the lives of those living in and around the district.

INTRODUCTION

In 1987 Ken Kingsbury, who had seen the creation of man-made lakes in Britain, decided that such a project was feasible and desirable for the keen water sport enthusiasts in Ashburton. He called a public meeting and a sufficient number of people attended the initial meeting to encourage those present to form a working party to investigate suitable sites.

A number of sites were considered and in 1989 a site was chosen within 6 kilometres of the main road and adjacent to the banks of the Ashburton River. The initial committee was enlarged and the committee formed an Incorporated Society with the aim of negotiation and purchase of land.

In 1990 the site became available to purchase with a price tag of NZD$120,000. The Society decided on a funding scheme of $100 joining

Long-term benefits and performance of dams. Thomas Telford, London, 2004.

fee and a $20 per year annual subscription. The local paper ran free advertisements and within seven weeks the society had purchased the land.

The Society, over a period of three years, obtained limited technical assistance, using local civil contractors and volunteers to prepare and apply for water resource consents. After three hearings, 29 resource consents were obtained relating to diversion and use of water to construct a dam to form a recreational lake. The majority of these consents related to the takes and discharges of water and sediments from/to Ashburton River and a number of minor streams.

A local contractor developed the idea of a staged construction sequence involving progressive impoundment with comprehensive monitoring of seepage piezometric gradient. The aim was to take flood flows from the Ashburton River and use the flood sediment to line the lake floor.

The Society had limited funds so a separate entity was created to control the development and construction of the recreational lake giving more protection to the Society and the new Trustees of the Ashburton Aquatic Park Charitable Trust (Trust)

The Trust was now responsible for management of construction and operation of the lake. The Society was responsible for fund raising to meet requests by the Trust.

DEVELOPMENT OF LAKE CONCEPT

Tonkin & Taylor Ltd (T&T), Environmental and Engineering Consultants became involved during the last resource consent hearing and provided detailed technical support. This led on to the development of the lake layout and development of a construction sequence for the Trust.

T&T suggested an assessment of all the risks to the project. A ‘risk management’ workshop was held to help give clear focus and direction to the Trust. T&T then developed a staged programme to address/manage each risk, involving and reporting to the Trust with up to date cost estimates.

Each of the project risks was broken down into separate packages for the Trust to consider. Each risk and mitigation measure had to be seen as practical and affordable.

The approach became “which is the current highest risk to the Trust”. T&T spent considerable time and energy breaking down the risks and the steps needed to resolve and react if needed.

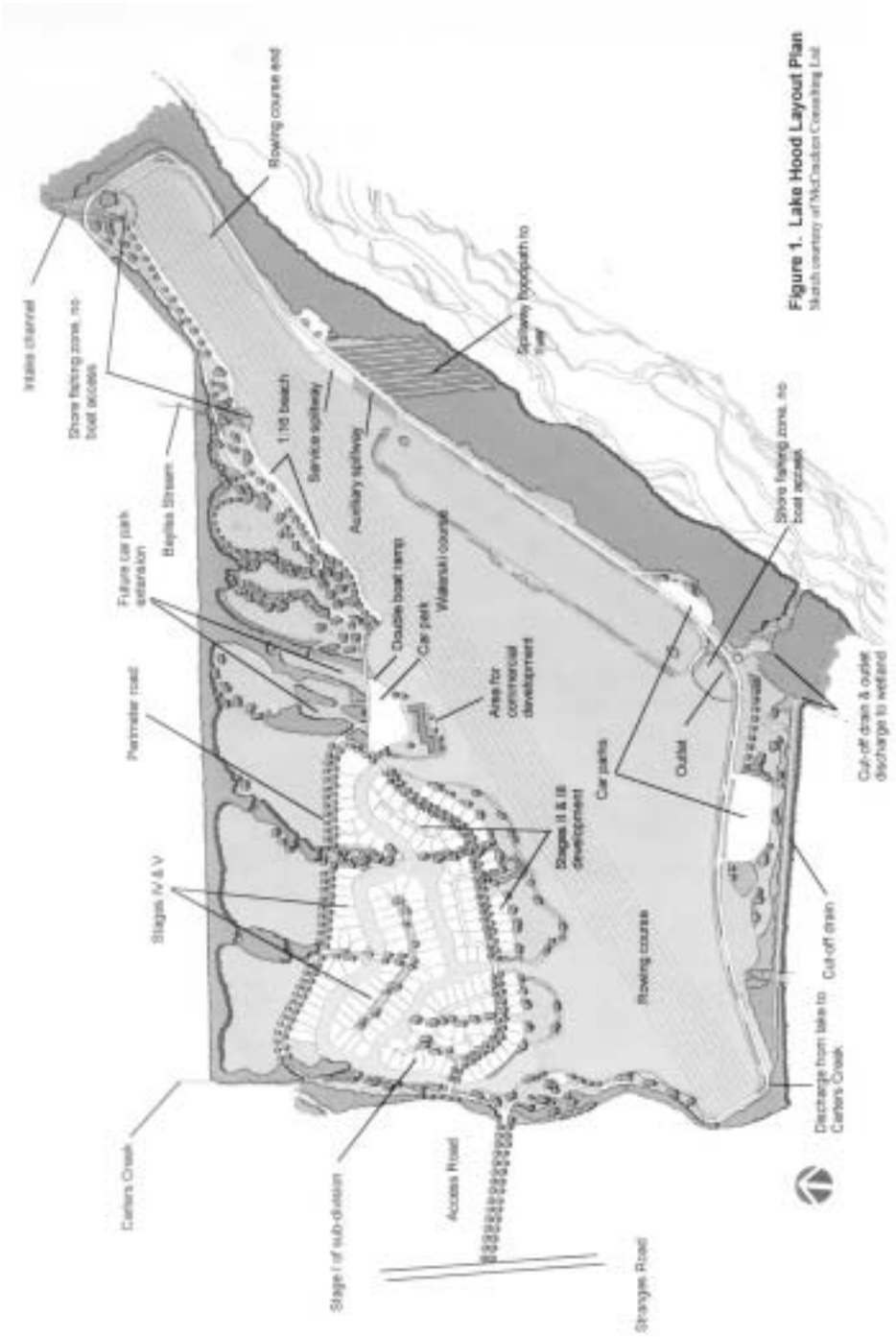

Figure 1. Lake Hood Layout Plan

The Trust kept the Society and community informed of each risk item that was being addressed. This helped when it came to the fund raising for each item. The community became increasingly committed and enthusiastic about the project as it developed to fruition.

Field trials

One of the major risks to the project was the source and installation of an economical liner material.

The construction of the lake above the ground water table, over an existing floodplain with highly pervious cobbles, resulted in the crucial design task of preventing excessive seepage losses. Construction of an adequate lake floor liner that ensured water would be retained was critical to the success or failure of the project. The deepest section of the lake is about 6.5 metres. This was the largest risk to the project.

A modified silt liner was proposed and, with detailed computer modelling combined with field trials, was decided upon as the best way forward. A farmer from an adjoining property, who supported the project, indicated that silt on his property could be used. The silt was from 1m bgl (below ground level) to 2.5 m bgl.

A MODFLOW model was developed for the 2.5 ha trial pond with in excess of 20 peizometres installed.

The 2.5ha trial pond was constructed to determine the depth of silt to be placed over the existing soils to meet several important conditions:

a) Reduce seepage to hold the lake above natural ground water level
b) To ensure lake seepage was less than 500l/s as required by the resource consent
c) To ensure that groundwater rise at the downstream boundary was less than 150mm.

Silt was spread over the ground to predetermined depths and cultivated into the existing soils to a depth of 300mm, using typical farming equipment.

The new soil mix was then compacted to form the lake floor liner. The trial showed that an average of 150 to 200 mm of silt was necessary to provide a suitable liner material. It was difficult to confirm the risk and options available should the liner not meet the Resource Consent conditions.

A local source of natural bentonite clay was found (250 km round trip). T&T investigated the material and decided that is was suitable if it could be made into slurry and dispersed. Local transport firms were informed and

several came forward and transported, at no cost, several loads to the site for a trial.

A team of 20 local Society members came to help break up the clumps of natural bentonite before it was put into a grout pump and pumped to the trial lake floor. After half a day it was found that this was not going to be practical on a large scale. The material was too "plastic".

Bentonite was placed at 10m centres around the lake edge, chopped up as much as possible by the Society members using shovels and spades, and then thrown into the trial pond using an excavator. To disburse the bentonite the Society members used two jet boats and one outboard powered boat for a period of five hours.

The piezometre readings over the next couple of weeks showed quite a step in reduced permeability of the liner as the bentonite moved to areas of high seepage. The trial pond was drained and on visual inspection a thin film of bentonite was found on most of the trial pond floor. The MODFLOW model was now calibrated ready for the main lake. Seepage was estimated at 200 to 250 l/s, half of the consent requirements.

Construction

Major fund raising began in 1999 and lake construction was tendered and prices confirmed. Major grants were sought to raise the required NZD $3.95 M including 10% contingency and comprised the following:

i)	New Zealand lotteries board	$1,200,000
ii)	Community Trust	$750,000
iii)	Ashburton District Council	$650,000
iv)	Loan from Ashburton District Council	$1,000,000
v)	Ashburton Trust	$200,000
vi)	Public donations	$150,000

Construction started December 2000. Public viewing platforms were built with controlled access to areas for the public to view construction progress.

Public open days were held every three months on site with buses taking the public around the site explaining where the status of construction was at and what was to happen next. This Public Relations exercise was considered necessary as the Trust depended on local support.

During construction another trial lake was developed (15ha. Sited as part of the final lake) and it was used to check that the assumptions made in the trial pond and MODFLOW model were correct.

The other purposes of the trial lake were

a) To determine the response of the water table to a known recharge
b) To locate areas of floor liner with high leakage by identifying local groundwater increases
c) To establish the need for a groundwater cut-off drain along the southern boundary (mitigation measure to stop ground water rise being greater than 150 mm)

The test was to give certainty and assurance to the Trust in several areas.

a) That the liner was working
b) Would the contingency allowed for bentonite be required? If not, the budget surplus would be used to redesign the lake to eight rowing lanes not six
c) Could all the resource consents be met, in particular, the groundwater rise at the boundary?

The MODFLOW model predicted the groundwater rise at the boundary, would be in excess of the Resource Consent requirement, however the consent conditions could be met with the installation of the cut-off drain.

	Field Results	MODFLOW Model Results
Predicted Seepage	77 to 140 l/s	93 to 151 l/s

Several meetings were held with the Trust to explain the 15 ha trial lake results and make recommendations from these results. The Trust decided to install the cut-off drain and go back to the public to raise money for the additional rowing lanes.

The lake was completed on 15th December 2001 and during Christmas and New Year 2001 the mean annual flood in the Ashburton River occurred. The lake was quickly filled by the floodwater. It transpired that this was the best thing that could happen for the lake, for a week floodwaters were taken, which successfully helped seal the lake floor with natural flood sediments.

Intake during normal flow

Intake during flood flow Jan 02

The lake was monitored for nearly a month and showed the average seepage to ground was between 101 l/s and 115 l/s with 97.5 % confidence.

The cut off drain was installed along the southern property boundary between 28/1/02 and 8/2/02. Ground water level readings dropped and became stable and the resource consent conditions were met.

The lake was officially opened on 28 April 2002. The high level of attendance reflected the support from the community.

Lake Hood – Typical weekend

CURRENT USE OF THE LAKE

Service clubs

As with any rural district and community, Ashburton has a multitude of active service clubs. These clubs have become increasingly supportive in several areas that in time will see an increase in the use of the lake and any ongoing fund raising. These clubs have attended to landscape plantings on the site and developed walking paths and mountain bike tracks. Ashburton Jaycees, who have run a triathlon for the last 17 years, had a new venue for the event almost purpose built.

Ashburton College

Ashburton High School has a role of 1150 pupils and accommodates year 9 through to year 13 students. Currently the school is encouraging students to join the Rowing Club and gives students leave to attend training and events.

In time, Ashburton College would like to have training courses in place for yachting and canoeing. Unfortunately New Zealand Government legislation under the Health and Safety Act, combined with the personal responsibility that teachers/instructors now take for school field trips, has had a negative impact on outdoor school activities. The New Zealand legislation has made it so much of a burden on schools that on many occasions schools do not contemplate activities off the school grounds.

Ashburton College's Principal has already seen the 35 students involved in rowing become more focused and willing to accept challenges. The school is looking at ways of managing the risk of programmes involving outdoor water events. Once this is remedied Lake Hood will become a great resource to Ashburton College.

Lake community

At the end of November 2003, two families live permanently at the lake sub-division with a further four houses currently being built. A total of 31 sections out of 35 Stage 1 sections have been sold. Stage 2 of the sub-division is currently being designed for construction in 2004.

New residential houses under construction

The completion of the first houses has resulted in a dramatic increase in the sale of remaining sections. Now that families are residing at Lake Hood there is already the feel of a community. In time these local residents will enjoy a rural lifestyle with a water front aspect.

Sports clubs

With Ashburton previously being approximately 1½ hours away from facilities suitable for water sports activity (other than jet boating), Lake Hood provides an ideal venue at their back doorstep. Consequently the level of activity in leisure water sports in the Ashburton area has risen.

Listed below are some of the new clubs recently established in the Ashburton area:

Rowing	75 members
Sailing	32 boats
Water skiing Club	28 members

Sports clubs an hour away in Christchurch travel to Ashburton for training and 'day out' events.

The Lake's effect on sports clubs has already shown signs of being of significant benefit to those other than water sports. There has been an increase in general support for other clubs e.g. cricket, tennis etc. It was found that parents of children playing cricket or tennis on a Saturday now became more involved in the sport. Where previously parents would drop the children off, go home and pack up the boat to go away 'up country' for water-skiing etc., this was now not necessary.

The resulting effect on these clubs is viewed by locals as having a very positive influence on community spirit and on the sporting clubs themselves.

Ashburton sailing - Club day

<u>Ecology</u>

The new lake has had an impact on the local ecology. Transforming what was grass farmland into a lake and wetland hinterland. Already there are signs of wildlife taking up residence. Trout have been released for recreational fishing. Careful plantings of native and appropriately introduced species have initially had positive results both aesthetically and practically on the lake environ.

LONG-TERM BENEFITS AND PERFORMANCE OF DAMS

Commercial

Local businesses have invested in the lake during feasibility investigations, construction and by way of sponsorship of clubs and events on the lake. They are already seeing results from their investments in terms of increased sales, new developments and new industries.

New businesses have emerged catering for water sports selling new and used powerboats, used sailing yachts, water ski equipment, canoes, kayaks and other boating accessories. Local motorcycle shops have expanded to cater for jet skis and mechanical servicing of boats.

The community is affected each time there is a significant event held on the lake. Events such as the New Zealand Long Distance Canoe Meet or the New Zealand Powerboat Racing National Championships impact right throughout the community. Such businesses as petrol stations, hotels, motels, company groups, restaurants, and supermarkets are all positively affected.

New Zealand Power Boat National Championships April 2003

The hotels have noticed increased use of their facilities, conference rooms for meetings and after match functions. The closest Tavern to the lake is doing major redevelopment, increasing meeting room and restaurant capacity and installing a drive through bottle store.

The local hotels are part of a District Licensing Trust. The trust is proactive at giving support at sponsoring events or with capital support for equipment for water sport clubs. They have become the ‘anchor’ sponsor for the annual ‘Aquafest.’

Local attraction

A passive use of Lake Hood has been use of the lake as a local point of interest. Local residents and tourists use the lake as a quiet place for picnicking, walking and as spectators of water activities. As facilities grow this type of use will only increase.

Lessons learnt when dealing with the community

- A community-based project invariably starts with a few keen individuals who volunteer their time.
- Keep the community involved and informed from inception to completion
- Keep development transparent – so that everyone knows what is happening
- Ask for help
- Where possible use local suppliers and businesses.

CONCLUSIONS

Ashburton is fortunate to have long twilights in the summer and a warm climate. With the lake so close to the township locals comment it is noticeable over just one summer the changes in family use of the lake. Whether involved in water sports or not, families appear at the lake edge to have a barbecue in the evenings. On the weekends the lake abounds with water craft of all shapes and sizes and the continuing development of the lakeside subdivision is offering a choice of lifestyle opportunities.

Over time and generations the culture of the community will adapt and embrace the lake as part of its fabric.

The lake has had a ripple effect throughout all aspects of the community. The dreams of a small but determined group of people have been realised to benefit the individuals and community as a whole, not just now but in the years to come.

ACKNOWLEDGEMENTS

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Balancing the costs and benefits of dams: an environmental perspective

Dr. U COLLIER, Living Waters Programme, WWF International

SYNOPSIS While dams have brought many benefits, they have also caused major environmental impacts, especially on freshwater ecosystems which are suffering a serious decline. This paper explores how the benefits promised by dam schemes can be gained without excessive, unacceptable environmental costs, with a particular focus on Europe. The Spanish National Hydrological Plan is used as an example of an ill-conceived, unbalanced scheme. The paper then looks at examples from Zambia and Switzerland to show how mitigation measures can reduce the impacts of some dams, while still maintaining economic benefits. The paper promotes the decision-making framework of the World Commission on Dams as the way forward.

INTRODUCTION

Dams have played an important role in development for centuries, if not millennia, and have created a range of socio-economic benefits (WWF, 2003a). However, the World Commission on Dams (WCD) found that these benefits often come at an unacceptable and unnecessary environmental and social cost (WCD, 2000). Perceptions as to what is acceptable or not vary between different sides of the dams debate. While economic cost and benefits are relatively easy to calculate in financial terms, environmental costs are often less quantifiable, thus making it more difficult to arrive at a balanced assessment of all costs and benefits. To some extent, the same applies to social costs, although when it comes to the displacement of people or loss of agricultural lands, such costs are easier to calculate.

The environmental impacts of dam projects can be wide-ranging and diverse. Some impacts are directly related to the construction phase and flooding through the reservoir. Downstream impacts from the operation of dams can be significant. Major impacts can also be caused by civil works such as access roads and power lines. In many cases, some of the worst effects can be avoided through mitigation measures, yet sadly such measures are not applied universally. Unnecessary costs can also caused by

Long-term benefits and performance of dams. Thomas Telford, London, 2004

the failure to carry out a comprehensive options assessment (as proposed by the WCD), resulting in the construction of dams where there may have been suitable alternatives, such as demand side management.

Not all impacts can be mitigated and in the worst case, they can result in the destruction of unique habitats or even species extinction. Such cases are likely to be considered 'unacceptable costs' - not only by environmental organisations but also by key decision-makers. For example, the World Bank uses the loss of endangered species as a key criterion for evaluating dam projects.

VALUING ENDANGERED SPECIES

According to WWF's Living Planet Report, the world is currently undergoing a very rapid loss of biodiversity comparable with the great mass extinction events that have previously occurred only five or six times in the Earth's history (WWF, 2002). In the last 30 years, freshwater species have seen a particular serious decline, with 54% of 195 indicator species showing a population decline. Dams are one of the factors in this decline, in particular through their effects on fish migration and impacts on downstream wetlands.

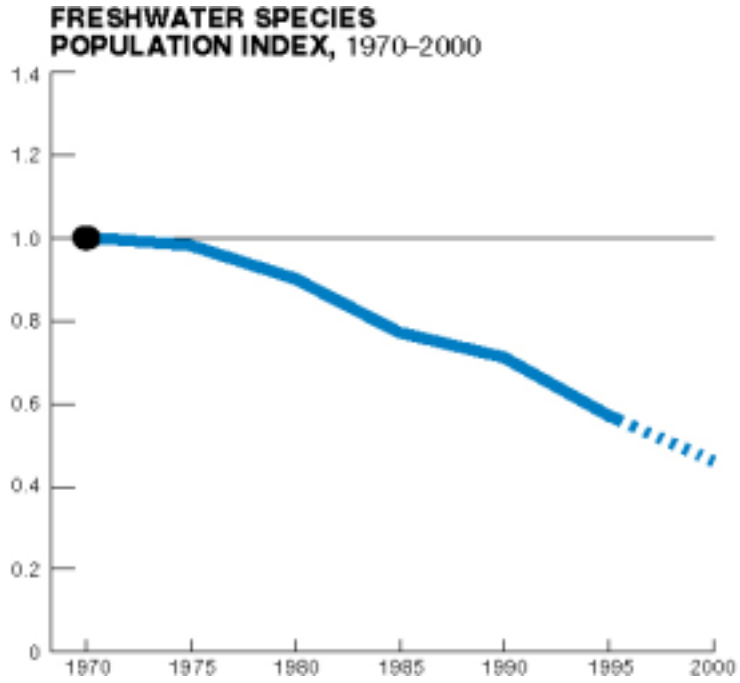

Figure 1: Freshwater species decline (from WWF, 2002)

Some dam sites are particularly threatening as far as endangered species are concerned. One extreme case is that of the Kihansi spray toad (*Asperginus*

nectophrynoides) which lives only in the fine mist created by the cascading waters of the Kihansi Falls in the Southern Udzungwa Mountains of Tanzania. Diversion of the Kihansi River for power production resulted in the threat of global extinction for the spray toad and possibly other species in the Gorge. The original EIA failed to look at the downstream impacts of the dam, which was obviously a major omission. Mitigation measures (i.e. spraying the toads' habitat artificially) have resulted in a loss of 15 MW of capacity at the 180 MW plant. Saving the toad has thus come at a considerable economic cost.

But how do you value the survival of a unique species of toad? Clearly, one cannot put a monetary value on such a species. The Convention on Biological Diversity, ratified by 188 countries, recognises the intrinsic value of biodiversity and requires the promotion of viable species populations. In Europe, habitats and species are also protected by a various national and European Union (EU) legislative measures, as discussed below.

EU ENVIRONMENTAL PROTECTION

In Europe, there are currently around 5500 large dams in operation. Few European rivers (or stretches of them) are unregulated and there has already been a major freshwater habitat loss. At the same time, environmental protection is high on the agenda in many European countries, hence new dam proposals are often met with considerable opposition.

With the expansion of the EU in 2004, the majority of European countries (including those who aspire to future membership, such as Turkey) will have to conform to EU environmental legislation. In principle, this legislation will provide clear guidance as to where dam projects might be acceptable. Key legislative measures in this context are the Birds (79/409/EEC) and Habitats Directives (92/43/EEC), as well as the Water Framework Directive and the Environmental Impact Assessment Directive. In the future, the Strategic Environmental Impact Assessment Directive (2001/42/EC) will also play a role for programmes and plans.

Under the Water Framework Directive (2000/60/EC) member states are expected to prevent the deterioration of surface waters. This should in principle protect sites that achieve good or very good ecological status. The Habitats Directive requires member states to prevent the deterioration of natural habitats and the disturbance of species in designated areas (so-called Natura 2000 sites), which should mean protection from developments such as dams. However, 'overriding public interest' can be used by member states as a way out. Despite these ambiguities in European legislation, habitats and species protection are a fundamental requirement that needs to

be taken into account in siting decisions for dams in the region. Yet, as the following example shows, not all member states take this seriously.

SNHP – UNACCEPTABLE AND UNNECESSARY

One project that stands out both in terms of its sheer scale and its infringement of European legislation is the Spanish National Hydrological Plan (SNHP). The SNHP, approved in Spanish law in 2001, consists of two parts:

- A water transfer from the Ebro River, impacting the Pyrenees, Lower Ebro basin and Ebro Delta;
- An investment programme to build more than 100 dams and associated reservoirs and canal networks throughout the rest of the country, re-routing another 35 rivers and tributaries.

Figure 2: Spanish National Hydrological Plan (SNHP). Map of the planned use of Ebro waters in the SNHP. Spain

The SNHP is likely to have major negative environmental impacts. Following an initial assessment, WWF found that 47 of the planned dams are likely to have a significant impact on at least 46 of the official Sites of Community Importance (SCI) proposed by the Spanish Environment Ministry for the Natura 2000 network. There are 35 dams that are situated completely or partly in Natura 2000 sites. At least 126 Important Birds Areas and 86 Special Protected Areas (designated under the Birds Directive) will be affected, including at least 14 habitat types and 18 species. While the exact impact is not known in the absence, at this stage, of individual EIAs, the plan undoubtedly puts huge development pressures onto sites that should be protected under European law.

Furthermore, the Ebro Delta is currently undergoing serious erosion due to lack of sediments (held back by existing dams in the Ebro river basin). This condition will deteriorate with the SNHP because the Plan does not acknowledge the need for a minimum flow of solids.

The Plan fails to give proper recognition to alternatives such as water demand management and makes assumptions about future demand (especially from agriculture) that are unlikely to materialize. According to an independent assessment by the Third World Centre for Water Management, the SNHP in its present form cannot be justified for economic and environmental reasons and it would be a very expensive 'white elephant' (Biswas and Tortajada, 2002).

THE WAY FORWARD – TOWARDS GREENER DAMS?

Implementing the WCD in Europe

With 5500 large dams in operation, Europe has already heavily dammed most of its major rivers. However, there are still numerous new dam projects, especially in Spain and Turkey. Obviously, the development pressures (as well as water stress) in these countries are greater than elsewhere in Europe, while their storage and hydropower potential is much less developed. At the same time, those countries also have some of Europe's most valuable ecosystems.

So how can some of this potential be developed, without causing large scale destruction? Obviously, there are various requirements under European legislation, as mentioned above. However, the WCD provides additional guidance which needs to be implemented in Europe to avoid further large-scale damage.

Out of the strategic priorities of the WCD, 'comprehensive options assessment' and 'sustaining rivers and livelihoods' are particularly critical for protecting vulnerable environments.

Firstly, options assessment will ensure that alternatives to dams are given due consideration. As the example of the SNHP shows, demand-side management (energy or water conservation) can in many cases reduce the need for new supply through dams. Not every proposed dam can be replaced by a demand-side programme but there can be little doubt that the current supply-side mentality in water and energy supply needs to be redressed. This makes both economic and environmental sense.

Secondly, 'sustaining rivers and livelihoods' recognised the importance of rivers, watersheds and aquatic ecosystems as the basis for life and livelihoods of local communities. A basin-wide understanding of the impacts of development options such as dams is crucial. WWF promotes Integrated River Basin Management (IRBM) which aims to maximize the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems (WWF, 2003b). The WFD also requires river basin management, although its implementation schedule is slow.

Under this strategic priority, the WCD also suggested the development of national policies for maintaining selected rivers with high ecosystem functions and values in their natural state. WWF has long been campaigning for the designation of free flowing rivers. For example, in Iceland, where the Kárahnjúkar hydropower plant will cause considerable damage to two glacial rivers, WWF is urging the Icelandic government to afford protection to a third glacial river, Jökulsá á Fjöllum, including its designation as a Ramsar site.

Addressing existing dams

The WCD also stressed the need to address the environmental and social problems caused by existing dams. Considering Europe has already 5500 dams in operation, a key challenge is to ensure that they operate in an environmentally acceptable way. In the past, many dams where built without EIAs and without mitigation measures. Some mitigation measures can be introduced at a later stage, as the following two examples show.

Environmental flows in Zambia

The reduction of the downstream low of a river is one of the key ecosystems impacts of dams. Maximising the output of a dam can have serious consequences both for ecosystems and other users downstream. However, in many cases it is possible to adjust the operational regime of a dam to better meet a variety of needs. So-called 'environmental flows' provide critical contributions to river health, economic development and poverty alleviation (IUCN, 2003).

To demonstrate that environmental flows are not just the 'luxury' for rich developed nations, WWF is working with the Zambian Ministry of Water and Energy Development and the Zambian Electricity Supply Company to introduce environmental flows at the Itezhi Tezhi dam, upstream of the Kafue flats wetland. The restored flow regime will have benefits not just for wildlife but also for fisheries and cattle grazing downstream of the dam.

Naturemade hydropower in Switzerland

The naturemade green electricity label in Switzerland supported by WWF (www.naturemade.ch), accredits new and existing hydropower plants under certain conditions. To achieve the highest standard, the 'naturemade star' label, hydro plants have to meet strict environmental conditions. These include environmental flows, sediment flushing, fish ladders and protection of wetland habitats. Additionally, operators have to pay a percentage of their income into a fund for environmental improvement measures, including habitat recreation. 14 Swiss electricity suppliers have gained certification under this label.

EUROPE'S POOR RECORD

Despite some good examples, a recent WWF report on water management in Europe has shown key gaps in national water policies as far as dams and environmental protection are concerned (WWF, 2003c). In particular, the report identified the lack of strategies to maintain free-flowing rivers and too few regulations to monitor and reduce the impact of existing dams. For example less than 40% of the surveyed countries have obligations to maintain ecologically acceptable flow regimes downstream of dams and fewer than 30% require fish ladders or passes specifically tailored to the site and species where the dam is located. Even where these requirements exist (e.g. Switzerland, Poland, Hungary, Slovakia and Turkey), their practical implementation and effectiveness is poor and there little or no monitoring to check that measures have been put into place. So far, there is little evidence of the implementation of the WCD's recommendations.

CONCLUSIONS

Freshwater ecosystems are of crucial importance to human survival – they serve as spawning grounds for fisheries, as cleansing systems for pollution, and as sources for our fresh water. Nevertheless, the loss of freshwater biodiversity continues at a rapid pace. Dams are a major culprit in this process – yet the destruction caused is quite often unnecessary. While dams bring benefits in terms of water supply, electricity generation or flood control, often alternatives are available to provide the same services, sometimes even at lower cost. Where they are not available, careful siting and balanced operation can significantly reduce the impacts of dams. There can be little doubt that we need to find a better balance between costs and benefits. WWF believes that the decision-making framework proposed by the WCD points the way forward. Even in Europe, where the planning of dam projects is subject to various environmental directives, the WCD framework provides additional guidance that if adhered to, should enhance decision-making and help protect precious ecosystems.

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Follow up to the WCD Report - where has it gone?

J BIRD, Independent Consultant, formerly Coordinator of UNEP Dams and Development Project[1]

SYNOPSIS. Despite the wide range of responses to the report of the World Commission on Dams, there has been an increasing realization of the need to address its recommendations through appropriate national and institutional processes. Neither rejection of the report nor full endorsement hold the answer. This paper outlines some of the momentum being built by national follow-up processes and the actions taken by an increasing number of inter-governmental, bilateral and private sector organizations. Minimizing the financial, environmental, social and reputational risks associated with dam projects is at the centre of these initiatives and key concepts such as options assessment, public acceptance, benefit sharing and environmental flows are beginning to enter the mainstream of planning processes.

REACTIONS TO WCD: FROM REJECTION TO ENDORSMENT

A full spectrum of responses

It is hard to conceive a wider range of reactions to the World Commission on Dams Report (WCD, 2000) than those received, but maybe that is not so surprising given the intensity and polarity of the debate itself (DDP, 2003). There are those that reject the report outright and those that call for its immediate implementation as if it were law. What is interesting about the reactions is that they do not fit as neatly into pigeon-holes as our characterizations of stakeholder type would suggest. There is considerable diversity of reaction both between and within organizations, whether they be government agencies, professional associations, financing agencies, NGOs or affected peoples' groups.

Extreme headline reactions are there for those who wish to continue the polarization of the debate. At one end of the spectrum there is outright rejection of the Report by the Ministry of Water Resources of India (MWR, 2001) and a former President of the International Commission on Large Dams who stated that the Report '*made dams look like villains, to be*

avoided unless there is no other way out' (van Robbroeck, 2002). At the other end, passionate endorsement. For example on the day of the Report's launch, the International Rivers Network commented that it '*vindicates much of what dam critics have long argued*' and if applied, '*the era of destructive dams should come to an end*' (IRN, 2000).

Some critics' responses were influenced as much by their perspective on the composition of the Commission or the process it adopted as by its content. For example, the case studies in India and Thailand significantly influenced Government's subsequent positions on the WCD Report. Similarly, a number of agencies from developing country governments felt their views were not adequately represented (Dubash et al, 2001, p43). Other reactions were strongly influenced by concerns that the Report's recommendations could further burden the project appraisal process through incorporation, in their raw form, into safeguard policies of the multi-lateral organizations.[2] The World Bank explains that this will not be the case (World Bank, 2001).

Criticism was not limited to those involved with dam building. Amidst their support for the Report, some NGOs felt that it fell short of calling for a moratorium on dams. They proposed to test commitment to a new approach by requiring the legacy of past projects to be addressed before initiating new projects. Some had wanted more of a challenge to the prevailing development model and condemnation of vested private sector interests. Reactions voiced by a range of stakeholder groups after the Report's launch are recorded in the proceedings of the Third WCD Forum meeting (WCD, 2001).

Yet, between these extremes more than one hundred responses have been formally recorded and analyzed. It is evident from the follow-up around the world, that many more responses and comments are not available in the public domain. As is often the case, there exists a large middle ground, the silent majority, who neither reject nor endorse the Report. An analysis of reactions received provides an important reflection on the WCD Global Review and its three-tier recommendations, the 5 core values, 7 strategic priorities and associated policy principles, and the 26 guidelines (DDP, 2003).

Derailed or on track?

So, has the report fuelled or calmed the debate? Conflict has not mysteriously vanished. However, the process itself has built a culture and atmosphere wherein advocates both for and against dams can enter into a civilized and constructive discussion. There has been an opening up of space for dialogue. Follow-on discussions have started at a range of appropriate levels – global, regional, national, sub-national and community levels using

the framework from the Report. It is a framework that considerably narrows the areas of controversy, allowing areas of agreement to be acknowledged and areas for more intense analysis to be flagged.

Where the controversy lies is the more detailed recommendations for implementation – the guidelines. What is important now is to look beyond the extreme reactions that continue to occupy the public limelight, and examine the extent and way in which the Report is influencing planning processes and implementation procedures.

In its independent analysis of the WCD process, the World Resources Institute outlined its view on how the Report will be taken up, '*Over the long term, the bridge back to formal government and intergovernmental processes will likely be built incrementally, by incorporating practice into formal laws, in part through continued pressure by non-governmental actors*' (Dubash et al, 2001, p127). But added to these actors are the large number of people occupying the middle ground who also recognize that change is needed.

INITIATIVES FOR CHANGE

What are the driving forces behind the various follow-on processes, given that the WCD Report has no legal status internationally? Clearly it is not the Commission. That disbanded on the date of the Report's publication. The initiative of its Forum members taken in February 2001, to continue with dissemination and promote dialogue on its findings, certainly has played an important role. But even then, there need to be catalysts to sustain any process within countries or organizations.

Three primary drivers come to mind. Most prominent is campaigning by international and national NGOs at both project level and targeted towards specific individual stakeholder groups. They have kept the WCD report and the issues it addresses firmly on the global agenda. WWF also has a campaign to engage with financing organizations to promote the WCD recommendations (WWF, 2003) and at the same time has used hard-hitting advertisements in high profile magazines to deliver its message (for example The Economist, 2003). In this case, globalization, at least in respect of information exchange, is something fully embraced by NGOs (Gyawali, 2001).

Secondly, a number of governments from developed countries have indicated their broad support for the WCD recommendations. There is considerable synergy with their domestic policies and these positions are

reflected in their influence on the multi-lateral development banks and in their own development assistance programs.

Thirdly, the trend over the past decade towards corporate social responsibility and triple bottom line accounting on financial, social and environmental aspects of operations in the private sector has led to companies voluntarily subscribing to international initiatives such as the UN Global Compact, Global Reporting Initiative, UNEPs Finance Initiative and environmental management procedures under ISO 14001. Due diligence procedures have been strengthened accordingly in order to reduce reputational risk and caution association with potentially problematic projects. The example of the Brent Spar platform from the oil and gas industry demonstrates the adverse impact that negative publicity can generate and also highlights the lessons learnt and benefits of dialogue.[3]

In less developed countries and emerging economies, the drivers for change reflect a combination of the above sources, the influence of each depending upon the prevailing development paradigm, the institutional and governance structures and inevitably, the extent that the country is dependant on external financing for project development. Reformers within some government agents have initiated dialogue processes aimed at introducing appropriate reforms.

Facilitating follow up internationally

Both 'godparents' of the WCD process, the World Bank and IUCN-The World Conservation Union, have published detailed responses to the WCD Report outlining the subsequent actions they would take as follow-up.

After consultations with a number of agencies in its member countries, the World Bank's Board of Director's endorsed a statement that '…..*shares the core values and concurs with the need to promote the seven strategic priorities..*' while outlining where World Bank policy differs from the guidelines. As a practical element of its response, the World Bank promoted a 'Dams Planning and Management Action Plan' to promote good practice and support innovations in projects involving water resources, energy and dams. The Plan uses the seven strategic priorities as a framework to look at projects in the pipeline and intends to provide operational support services for critical elements identified by the Commission. A first output of the Plan is the development of a Sourcebook on Options Assessment (World Bank, 2003b).

There has been a considerable polarisation over the Bank's response, with a number of government agencies in developing countries encouraged by the

decision not to amend its safeguard policies, while critics pointed to a lack of commitment to the outcome of a process that it helped to initiate.

IUCN's response was more supportive. It recognized that work needs to be done to operationalize the WCD recommendations and encourage multi-stakeholder groups to progress further (IUCN, 2001). Three priority areas identified were regional strategies for engagement and supporting multi-stakeholder process; work on global policy processes related to sustainable development and links with the Ramsar Convention (Ramsar, 2002), the Convention on Biodiversity (CBD) and the private sector; and work on strategic analysis and tools related to dam development and operation, including a toolkit of environmental flows and improved economic valuation of ecosystem services. Many of the principles in the WCD report also feature in IUCNs Water and Nature Initiative.

Both the World Bank and IUCN were key players in establishing a global follow on initiative to WCD in the form of UNEPs Dams and Development Project (DDP, 2001). Together with representatives from a government basin agency, affected peoples' groups, the private sector and advocacy NGOs, they worked within the mandate provided by the Third WCD Forum meeting (WCD, 2001) to craft a multi-stakeholder process with a goal '*To promote a dialogue on improving decision-making, planning and management of dams and their alternatives based on the World Commission on Dams core values and strategic priorities*'. As part of the formulation process, the six member liaison group was expanded to a 14 member Steering Committee, adding two other government representatives, indigenous peoples' groups, utilities, inter-governmental organizations, professional associations, organizations working on options, and research groups.

In selecting this route, the global multi-stakeholder follow-on process was brought into the UN inter-governmental system, thereby providing confidence among some agencies critical of the WCD Report that the follow-up process would take account of their views and provide an environment within which they could participate in the project through the Forum. Taking over what he described as a 'hot potato', UNEP Executive Director Klaus Toepfer captured the challenge of the DDP, '*I believe that we have no choice but to find ways of crossing traditional divides, to act together and find solutions to what has often been a conflict ridden way of working..*' (DDP, 2002). Responding to this challenge, the membership of the DD Forum has increased to include the Brazilian National Water Agency (ANA), the Chinese Ministry of Water Resources, Turkey's General Directorate of State Hydraulic Works (DSI), India's Planning

Commission, Nepal's Ministry of Water Resources and Uganda's Ministry of Energy among others. The Forum of stakeholders forming part of the global dialogue process has expanded to 120 organizations.

Also at the global scale, the response of the World Water Council provides an insight into some of the challenges in taking the dialogue on dams and development further. Pointing to both positive and negative feedback from its members, the Council's official response acknowledges the important contribution of the WCD, supports the core values and strategic priorities, and recognizes that they have relevance to other infrastructure (WWC, 2001). In practice however, members of the Task Force on Dams established by the Council actively campaigned against acknowledgement of the WCD. This was evident at the Third World Water Forum, where they objected to direct reference to the WCD in the theme summary on dams, but was able to broadly accept its recommendations through a reference to *'A framework for planning and implementation based on values of equity, efficiency, participatory decision-making, sustainability and accountability'* and a series of principles that reflect many of the WCD strategic priorities (WWF3, 2003).

Beyond the perspectives of international organizations, there has been action at regional and national levels.

Regional initiative in Southern Africa

In response to a call from its Ministers, the Southern African Development Community (SADC) is adopting a two-fold strategy (SADC, 2003). It will comprise of a formal statement providing SADCs position on the WCD Report and a policy document on dams and development to guide future SADC involvement with dams related activities. Supported by the German agency GTZ and the DDP, initial drafts of the position paper and policy document are being prepared for review by a multi-stakeholder workshop in early 2004. They will be submitted for discussion in the formal committee processes of SADC and ultimately reviewed by the Committee of Ministers and approved at a SADC Summit.

National dialogues

A wide range of multi-stakeholder national processes have emerged since the launch of the WCD Report, many of which have been encouraged and supported by the DDP. A number are outlined below. Common characteristics include participation of all key stakeholders, government, endorsement by the responsible government agency, and a preliminary scoping stage leading ultimately towards recommendations on policy and procedures relevant to the local context. In some cases, translation of the WCD Overview and Report have been a pre-requisite to wider discussion.

Experience of these national dialogues outline in this paper is based on the writer's involvement (Bird and Wallace, 2002) and updates provided by the DDP.[4]

South Africa
Probably the most advanced of all the national follow-up processes, the South African initiative on WCD started life as a proposal to hold a meeting among two groups - the professional organization, SANCOLD, and the Department of Water Affairs. However, based on discussions with local NGOs and the transition WCD Secretariat, the process took on a more multi-stakeholder character with a Symposium organized for 23-24 July 2001. The overall consensus of the Symposium was reflected in the resolution that "*declares itself to be broadly supportive of the strategic priorities outlined in the WCD report, but believes that the guidelines need to be contextualized in the South African situation*".

Since then the elected Coordinating Committee, representative of diverse stakeholder groups, has met approximately at two monthly intervals. There have been two further multi-stakeholder forums to review a draft Scoping Report and assess recommendations on policy reform measures for the first three of the WCDs seven strategic priorities. The process is scheduled to be completed by October 2004 when the Committee's recommendations will be submitted to Government for consideration.

Vietnam
A multi-stakeholder consultation on the report of the WCD was held in Hanoi in October 2002 organized by the Ministry of Agriculture and Rural Development (MARD) with financial support from the Asian Development Bank (ADB). In advance of the workshop, MARD arranged the translation of the WCD Report and Overview into Vietnamese with assistance from DDP. Based on the outcome of the consultation, a proposal emerged for a two phase follow-up. Phase 1 prepared a scoping paper to examine the WCD recommendations in the context of Vietnam and identified areas of agreement, disagreement, opportunities and constraints. Workshop discussions on the draft scoping paper will then define the second phase to analyze key outstanding issues and make specific recommendations on policy and procedures to Government decision-makers.

Nepal
Presentations and discussions on the WCD Report were organized in Nepal in the two years since its launch, both by professional associations and NGOs. Although there was strong interest to build on these meetings, the lack of involvement of government agencies was a major constraint. A change of Government and a facilitation role from DDP saw the

establishment of a broad-based task force on dams and development and, in January 2003, the launch of a multi-stakeholder dialogue. Its aim is, "*To carry out national consultations on dams and development to consider the relevance of the recommendations of the WCD and other bodies in the Nepalese context with the ultimate aim of recommending the development and adoption of a national guideline for improved decision-making, planning and management of dams and alternatives for Nepal*". By September 2003, a scoping report had been prepared comparing the legal and regulatory framework in Nepal with the WCD recommendations, and identifying where reforms were considered appropriate in the local context. Discussions on a second phase started in November 2003.

Thailand

Translation of the WCD Overview into the Thai language formed the basis for a national multi-stakeholder meeting organized by the National Water Resources Committee in March 2003. The two-day meeting concluded with general support to the framework of core values and strategic priorities and agreed to establish a national task force on dams and development to take the process further and develop locally appropriate recommendations for government. In July 2003, the Ministry of Natural Resources and the Environment formally constituted the task force comprising government agencies responsible for and related with dam projects, river basin water user associations, NGOs and academic institutions. By examining the issues in a local context, the process has broadened its participation and included agencies initially reluctant to consider the Commission's recommendations.

Pakistan

In 2001, IUCN was requested by the Ministry of Environment to facilitate discussions about the WCD final report and develop locally appropriate recommendations. The process, supported by the Royal Netherlands Embassy in Islamabad, was delayed while institutional arrangements were worked out to ensure involvement of key government agencies responsible for dam projects in the water and energy sector. During this period, advocacy NGOs voiced concerns about being alienated from the dialogue. Subsequently, the WCD consultative process re-started with a series of workshops scheduled for September to December 2003. Other provincial consultations were initiated by the Pakistan Water Partnership, an affiliate of the Global Water Partnership.

Other national processes

Similar consultative processes are beginning to emerge in other countries. In Asia, an initial multi-stakeholder meeting was held in the Philippines in August 2001 sponsored by ADB and preparations are now underway to hold a second meeting in early 2004 with a view to setting up a national follow-

on activity. In Sri Lanka, a workshop was held in December 2003 initiated jointly by a Government agency and an NGO. In Latin America, a core group of stakeholders has met in Argentina to plan for a multi-stakeholder consultation on the report tentatively scheduled for March 2004 and in Brazil, an international meeting on dams and reservoirs that will also have a focus on domestic dams and development issues is being convened. In Africa, national consultations linked to the SADC process at various stages of preparation in Lesotho, Malawi, Mozambique, Namibia, and Zambia.

In Europe, a number of countries have developed a response to the WCD, with some convening multi-stakeholder meetings to consider both their domestic situation and their influence on international activities. These include Germany, UK, and most recently the Netherlands (Both Ends, 2003).

Interaction between the DDP and government agencies in China is opening a channel of dialogue on dams and development despite the clear reservations of the Chinese Ministry of Water Resources on certain aspects of the Report. DDP's entry into the UN system, coupled with the World Bank's response not to add any additional layers of safeguard policy, encouraged this engagement. The Chinese Ministry of Water Resources joined the DD Forum as an opportunity to both participate in the global arena and make known their experience and perspectives. The WCD Report is now being translated into Chinese.

In contrast, there has not been a similar relationship developing with the Water Resources Ministry in India that took a position of non-engagement on the recommendations of the WCD Report. As water resources is predominately a State matter, the opportunities for dialogue may be more promising at a decentralized level.

Private sector financing and export credit

On 4 June 2003, a group of four private banks signed up to the Equator Principles', in which they require an Environmental Assessment for sensitive projects and subscribe to the safeguard policies of the International Finance Corporation of the World Bank Group.[5] The number of banks endorsing the Principles has increased to eighteen as of November 2003. This initiative demonstrates an unprecedented realization in the financing sector of the need to address social and environmental issues to minimize risk to business, both financial and reputational risk. In parallel and leading on from this, an increasing number of organisations are addressing the WCD Report. Swiss Re, the reinsurance group, prepared a Focus Report on Dams[6] stating its support for the WCD's five core values and seven strategic priorities concluding that, '*It is Swiss Re's conviction that in the future,*

large projects should be handled in accordance with these principles and practices'. The banking group, HSBC, is working in conjunction with WWF to develop a freshwater policy that is expected to address many of the issues in the Report. Henderson Global Investors have used the Report in assessing whether companies are eligible to be included in their investment funds.

Some Export Credit Agencies have referenced the WCD recommendations as an influence on their new environmental policies (Neumann-Silkow, 2003). The Swiss export credit agency, ERG, has explicitly referenced the WCD recommendations in its EIA guidelines and requires an EIA Report to outline how the seven strategic priorities will be addressed in the context of a proposed project. New environmental guidelines of the Japan Bank for International Cooperation also drew on the WCD Report and include a number of the elements of the strategic priorities including the importance of environmental and social considerations in assessing alternatives, priority to the prevention rather than mitigation of impacts, early disclosure of information, recognition of the rights of indigenous peoples, agreement with affected people on mitigation measures and an emphasis on improving livelihoods.[7]

In June 2003, the Overseas Private Investment Corporation of the United States (OPIC) released a consultation draft revision to its Environmental Handbook to accommodate new polices on large dams and forestry.[8] OPIC announced '*it believes it is important to show leadership in adopting and implementing those elements of the WCDs recommendations that inform good development policy and that are within OPICs capacity to implement'*. The draft revision includes extensive references to specific strategic priorities and guidelines. Recent guidelines of the French ECA, Coface, also refer to the Report and incorporate some of its recommendations including benefit-sharing and environmental flows.[9]

With many of these processes, NGOs have expressed concerns that the organizations have been too selective and not gone far enough in endorsing the principles contained in the WCD Report. There are also many commercial financial agencies whose policies are not disclosed and have not yet addressed the Report. Whatever one's perspective on this, in comparison with the situation of five years ago, it is evident that a process has started to substantially address social and environmental issues in a more comprehensive manner and that it is likely to gain further momentum and evolve over time.

The regional development banks have generally responded by promising reviews of their existing policies. The Asian Development Bank, for example, published the preliminary results of its review in January 2002.[10]

Professional associations

Of the professional associations, the International Hydropower Association (IHA) has taken the most pro-active role in following up on the WCD Report. In contrast to the position of ICOLD and ICID, it engaged with the DDP as a Steering Committee member and Forum member in order that the position of its constituency on the future potential and direction of the industry is well represented. In parallel, IHA prepared Sustainability Guidelines that have embraced some of the WCD principles within a framework of promoting hydropower as a clean, renewable and sustainable technology.[11] They include, the concept of options assessment, informing and involving local communities in the decision-making process, benefit sharing and environmental flows.

Although not supportive as an international organization, individual national committees of ICOLD have been proactive in the DDP process, notably the British Dams Society that made a financial contribution and the South African National Committee on Large Dams that is a founding member of the SA Initiative on WCD.

WHERE TO FROM HERE?

The above responses and follow-up actions can be viewed in the light of the Commissioners own expectations. In the final chapter, Commissioners suggested that '*Nobody can of course simply pick up the report and implement it in full. It is not a blueprint*'(WCD, 2000, p311). Instead they proposed a series of entry points for different stakeholder groups among which are to include reviews of existing national procedures and regulations, encourage multi-stakeholder partnerships, address the legacy of past social and environmental problems, refer to the WCD principles in corporate policy documents, use the guidelines for screening and evaluating potential projects, and refine the tools proposed. Considerable progress is being made in these fields, but there are many other aspects still to be addressed.

Assessing the extent to which people have benefited as a result of the WCD Report is a long-term process and will gradually be informed by case by case experiences. The factors and influences are many and such a discussion will no doubt be as diverse as the debate on dams itself. However, there are signs that several of the principles espoused in the Report are beginning to enter into common usage. Many indeed entered the arena prior to the Commission as indicated in its broad knowledge base, albeit in limited

cases. The endorsement of such innovations within the comprehensive framework of the Report has raised awareness and provided examples of good practice with an added impetus. But no doubt, as with a dam project, the true benefits and costs of the WCD Report will not be known for many years after its 'commissioning'.

In the meantime, where will the dialogue go? Business as usual seems increasingly to be an option of the past. In addressing the issues and recommendations in the WCD Report, government agencies, utilities, developers, financiers and others proposing dam projects require more certainty that their proposals are both effective and sustainable, minimizing the financial, social, environmental, technical and reputational risk. They question though whether advocacy NGOs will continue to insist on full endorsement of the WCD strategic priorities and guidelines as a pre-requisite. In practice, the national dialogues based on the framework provided by the Commission, demonstrate that polarized positions can be set aside and progress made towards a more common understanding of what is appropriate within the local context.

The examples of the Equator Principles and OECD harmonization process for ECAs point to the advantages in taking a common approach to policy development among finance agencies. This could be extended to the arena of dams. But bearing in mind on government responses to the WCD report, such policy statements should incorporate sufficient flexibility to reflect differing contexts and the results of the relevant national multi-stakeholder dialogue on dams and development.

The national dialogues have indicated a way forward. The synergy with broader processes that encourage sustainable development, greater accountability and corporate social responsibility all provide an enabling environment for these reforms to emerge. But the process is not an easy one. For those with an engineer's training like me, used to traveling a path from A to B in a direct line, the uncertainties, deviations and delays associated with what are essentially political dialogue processes takes some adjustment. The ongoing processes show considerable promise and there are signs that some groups vehemently opposed to the WCD report are prepared to enter into dialogue under the new institutional arrangements. These are encouraging signals given the inevitable increase in calls for dam projects that will come in a response to the UN Millennium Development Goals for water supply, renewable energy and food production. However, despite this momentum, there remains a considerable challenge ahead to translate the outcomes of national level dialogues into firm commitments in the legal and policy framework.

A comment from the risk-averse private sector provides a fitting conclusion. In its Focus Report, Swiss Re makes a point about dams that is fundamental to all developers – private or public, '*For projects of this magnitude and complexity, risk mitigation and limitation must be a top priority'*. Failing to acknowledge and address the recommendations of the WCD Report is a strategy unlikely to minimize those risks.

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ENDNOTES

[1] The writer would like to acknowledge the assistance provided by the Dams and Development Project in compiling this paper and providing information on the various follow-up activities described.

[2] For example, the position of the Chinese delegation attending a regional workshop on the WCD report held in at ADB in Manila on 19-20 February 2001, see http://www.adb.org/Documents/Events/2001/Dams_Devt/Dams_devt.asp

[3] For a reflection on the Brent Spar experience see http://archive.greenpeace.org/pressreleases/oceandumping/1998nov25.html. There are parallels with the dams debate and interesting lessons learnt by Shell "*Dialogue should start as early as possible in decision-making 'Dialogue-Decide-Deliver' is better and less costly than 'Decide-Announce-Defend*"'.

[4] See http://www.unep-dams.org/document.php?cat_id=16

[5] See '*An approach for Financial Institutions in Determining, Assessing and Managing Environmental and Social Risk in Project Financing*' http://www.equator-principles.com/index.html

[6] See http://www.swissre.ch/INTERNET/pwswpspr.nsf/fmBookMarkFrameSet?Read Form&BM=../vwAllbyIDKeyLu/BMER-5HNHW9?OpenDocument

[7] See http://www.jbic.go.jp/english/environ/guide/finance/index.php and http://www.jbic.go.jp/english/environ/guide/finance/check/list02.php

[8] See http://www.opic.gov/EnvironASP/envbook_revisions.htm

[9] See *Environmental Guidelines on Hydroelectric Power Stations and Large Dams* http://66.102.11.104/search?q=cache:s8KkRk2nL9QJ:www.coface.com/_docs/barragesgb.pdf+coface+dams&hl=en&ie=UTF-8

[10] See http://www.adb.org/NGOs/adb_responses.asp

[11] See http://www.hydropower.org/1_5.htm

Political ecology of dams in Teesdale.

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SYNOPSIS. Between 1894 and 1970, six dams were built in the beautiful Pennine landscape of Upper Teesdale in North East England to supply industrial consumers on Teesside. Political influences on the decisions to build these impounding reservoirs are explored to discover the reasons for ignoring alternatives, some of them much less intrusive on the rural environment. Was the concept of a sequence of dams in upland dales overtaken by a megadam with consequent major transfers of water between catchments? With hindsight, should preference have been given to provision of domestic and industrial water storage by the "Metropolitan" solution of pumped storage off-river reservoirs close to the point of use? By asking who benefits and who pays, economically, socially and environmentally, this historical analysis presents a wide perspective on the social and environmental impacts of dams and reservoirs with implications for future choices.

INTRODUCTION

From the 19th Century, Pennine dams were regarded as a "natural" solution for water supply for growing industrial cities in the valleys and nearby lowlands. Over 200 were built between 1840 and 1970. The physical advantages of altitude allowing gravity flow from upland sources to lowland consumers, high rainfall and low evaporation, rivers transporting soft water in valleys topographically-suited for impoundment, gave the impression that this solution to water supply was pre-determined, a right and proper use of natural resources.

Industrial Teesside with its thirsty iron and steel works and heavy chemical factories sited around the estuary of the Tees, in a rain shadow area, followed this pattern of looking to the hills for water for a century. But a closer look at the history of the six dams built in Teesdale shows that the choices were strongly influenced by politics. Increasing wealth of urban industrialists on Teesside bargained with an almost feudal society of aristocratic Pennine landowners, threatened by new taxes, and their small tenant farmers, who had few resources and little power. Rights to build dams were easily negotiated with the gentry but post-Second World War opposition grew from middle-class defenders of the countryside.

The argument is proposed that engineering solutions to water supply to Teesside have been influenced strongly by politics. Historical vignettes, illustrate the role of engineers exercising power, in varying contexts, over

Long-term benefits and performance of dams. Thomas Telford, London, 2004

development of water resources. Attention will be given to neglected alternatives. Once the interplay between technology and politics is recognised, "what if?" games may be played to assess how different political priorities might have led to outcomes more in tune with 21st Century ambitions in Europe for a water environment with a high degree of biological health.

JAMES MANSERGH AND JULIUS KENNARD: ENGINEERS AND POLITICAL ACTORS

James Mansergh and the first phase of dam building.

The first water undertaker for Middlesbrough and Stockton was a private company set up by the local industrialists, who organised direct abstraction from the Tees at Broken Scar (Figure 1), where a steam pump was installed in 1860, designed by Messrs J & C Hawkesley (Mansergh 1882). Later, the local Corporations claimed that the water supplied was sometimes unfit to drink and that the Tees was being ruined by abstraction. The Mayor of Middlesbrough had ambition to bring purer water from Pennine reservoirs in the manner of Manchester Corporation who, in 1847, took the whole of the Longendale valley to construct a series of stepped reservoirs (Walters 1936). He needed the help of an engineer who was a skilled politician as well as an expert in dam building to help him take over the private company by compulsory purchase.

He hired James Mansergh, who had designed a series of six dams in the Elan and Claerwen valleys in 1870-71 for the water supply of Birmingham. Mansergh held that it was "incontestable" that "the purveying of water to the public should be one of the distinctive functions of the responsible sanitary authority of any district" (Anon. 1905). His political beliefs suited and his advocacy skills won the day; the Stockton and Middlesbrough Corporations Act of 1876 was passed after a struggle lasting 42 days in committee in both Houses of Parliament. The Act authorised a new body, later to be called the Tees Valley Water Board, to abstract 39,096m^3/d from the Tees at Broken Scar and to construct, in the tributary Lune and Balder valleys, six reservoirs starting with Hury and Blackton.

Far from leading to an instant improvement of water supply with increased investment, taking the company into public ownership paralysed activity for years. Compulsory purchase did not come cheap: the legalities of the Act cost Middlesbrough and Stockton Corporations each £12,403 (£0.56M) (Note 1), whilst the cost of purchasing the company amounted to £845,986 (£38.3m) (MRO 1898a). This financial burden was so substantial that progress with the proposed upland reservoirs, then estimated to cost a further £700,000 (£31.7M), was seriously delayed. Until 1882, the new Water Board ran at a loss (MRO 1898b). Without the backing of the

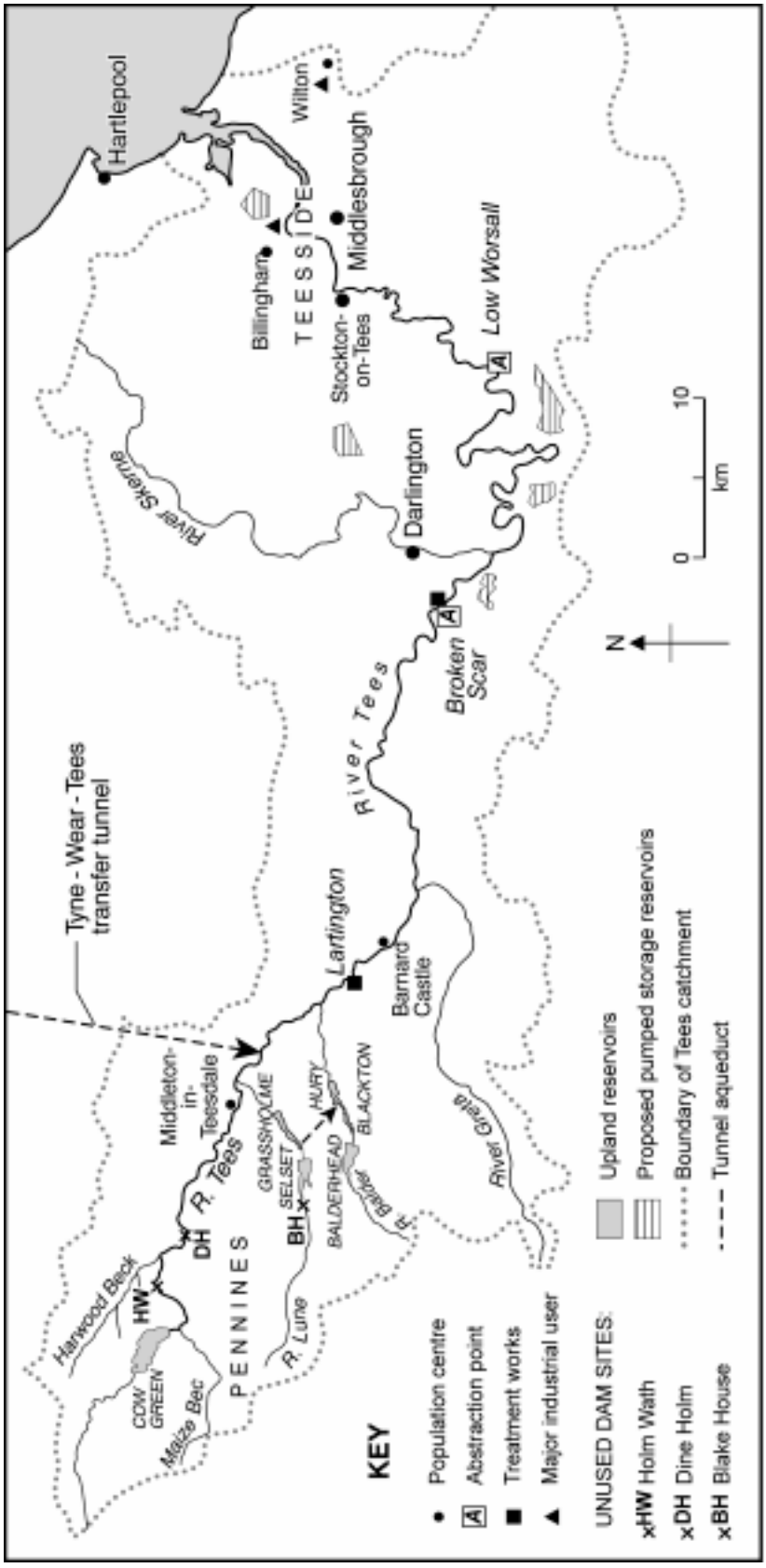

Figure 1. Teesdale Reservoirs

Corporations and their ability to obtain long-term loans, bankruptcy would have loomed.

Twelve years after taking over the water company, the Mayor of Middlesbrough and Chairman of the Water Board was called to account. Pig iron production demanded more water and the Stockton and Middlesbrough Corporations had to apply to Parliament for further powers to abstract even more water from the Tees at Broken Scar to tide them over until one or more of the upland reservoirs had been constructed. At the House of Lords committee hearing, the Mayor was subjected to hostile questioning by Counsel: "Is there a single work; that you undertook, that you have done, or a single promise you have made at this time that you have not violated?" The Mayor was reminded that, as a prelude to the takeover of the private company, he had decried its intention of taking more water from the Tees at Broken Scar; yet now the Mayor was asking to do the same (MRO 1884). Nevertheless, powers were extended following a promise of an early start on the proposed Hury reservoir.

Financial difficulties continued and reports of enteric fever were still being attributed to the drinking of water from Broken Scar (Anon.1890-91). The costs for Hury alone had doubled from the original estimate of £108,637(£7.1M) to £224,933(£14.7M) (MRO1898a). New borrowing powers were required to ensure completion of Hury and Blackton.

James Mansergh must have been a patient man. His plans for the Elan & Claerwen reservoirs had taken 20 years before adoption and his Teesdale scheme, approved in 1876, was only partially built before his death in 1905. His scheme involved relatively pure water being piped from two connected reservoirs: Hury (1894) and Blackton (1896) to a filtration plant at Lartington and then to Teesside. James Mansergh took the provision of compensation water very seriously, although he appeared less sensitive to biological issues. He had planned a third reservoir, Grassholme, in the neighbouring Lune valley mainly to remedy "serious injury" being caused by excessive abstraction (Note 2). Grassholme was connected to Hury by an aqueduct driven through the watershed so that water, above stipulated levels to ensure continuity of compensation releases, could flow into Blackton and Hury and thence into supply. Grassholme was not finished until 1915, built under the supervision of James Mansergh's son.

Financial compensation was substituted for building fish passes over the dams. A donation of £1,250 (£0.08M) "to be expended at such times and in such manner as the Board of Trade in their discretion may think fit for the permanent improvement of the salmon fisheries of the Tees Fishery District" sufficed to grant the Water Board relief from the requirements of

the Salmon and Freshwater Fisheries Acts 1861 to 1892. In whatever way the Board of Trade spent the donation, it did not stop the subsequent rapid decline of salmon fishing on the Tees, caused by pollution of the estuary.

An alternative in the search for pure water might have been exploitation of local aquifers but one of the reasons James Mansergh avoided using groundwater was the poverty of its legal protection: "there was no right in underground water unless it could be proved that such water was flowing in a defined and locatable underground channel". This meant that there was no assured compensation if another party drilled a well nearby, reducing supply from the earlier well (Mansergh 1901).

Features of this early phase of dam building included:

- Importance of a champion for the reservoirs who could speak with authority to investigating committees.
- Need for an effective management organisation. The new Water Board took years to build up the necessary finance to implement plans approved in 1876.
- Ease of negotiations with Pennine owners with large estates. Agreements allowed retention of gaming rights, so that sale of the land did not affect landowners' life styles, whilst providing much needed cash to set against increasing taxation and agricultural depression.
- Tenant farmers had little protection except that there might be resistance from the Local Government Board, if it were to be faced with an excessive number of displaced people (more than 10 families).
- Before introduction of chlorination, there was a premium on the relative purity of the upland water.

<u>The second phase of dam-building in Teesdale led by Julius Kennard</u>

Industrial contraction during the interwar years affected the finances of the Water Board so badly that it had to raise the water rates whilst there was much hardship from unemployment. Spens (1948) attributed the lapse in investment in the interwar years also to poor management before an "energetic and enthusiastic" Engineer and Manager was appointed in 1941. Construction of the fourth Mansergh dam at Selset above Grassholme had been planned during the War but no funds were available. Expansion on Teesside of heavy manufacturing, despite its high water demands, was given encouragement by the post-war Government. Imperial Chemical Industries (ICI) opened its Wilton petrochemical works in 1949 and began a programme of rapid expansion (Owen, 1999).

LONG-TERM BENEFITS AND PERFORMANCE OF DAMS

Water demand on Teesside became pressing and the Water Board needed an engineer with both experience in building dams and political skills to win Parliamentary approvals. Heightened political awareness and strengthened defence of alternate land uses faced Julius Kennard on his appointment as consulting engineer to the Tees Valley Water Board in 1952. Promotion of dams in the upland dales now invited opposition from organisations such as the Wear and Tees River Board, the Nature Conservancy, the National Parks Commission, the National Farmers Union, the Ramblers' Association and many other bodies with different priorities for the use of the uplands.

Like James Mansergh, Julius Kennard acted politically both in planning reservoirs, in sounding out opponents and in promoting the schemes. The practice at the time was for the consulting engineer undertaking the promotion to be appointed to design the works approved. This dual role led to preference for supply rather than proposals for demand reduction; and for the form of supply of the type preferred by the appointed engineer, in this case upland reservoirs. Julius Kennard added another reason for his choice: "an underground water scheme will involve the promotion of numerous Orders, which, if objected to, will necessitate local enquiries, and it is more than likely that protective clauses will be included on behalf of existing users"(Kennard 1965).

With a prestigious remit to provide structural solutions to increase supply, Julius Kennard at first followed James Mansergh's plans, developed by his son, for a second reservoir in the Lune valley at Selset, above the Grassholme reservoir, and he reported to the Water Board (1952) that "our survey confirms the information which Mssrs. Mansergh set out in their report dated 1/10/20 suggesting an earth embankment dam of the usual design." He also quoted with approval Ernest Mansergh's views:

> 'Some years ago, and not very many, "compensation water" was looked upon as something bordering on the sacred, and rightly so, because after all it represents a form of property in which others have a right and interest, sentimental perhaps to a very large degree, but nowadays compensation water must be looked at from a more materialistic point of view, not who has a right to the water, imaginary or real, but to whom is the use of the water going to be of the most benefit.'

This more materialistic point of view was endorsed by the Water Board, and drastic reduction in compensation water was sought as a stop gap, until further upland reservoirs could be built.

The Wear and Tees River Board, set up in 1952 with wider terms of reference but excluding water supply, did not view their reasons for wanting more water in the Tees as "sentimental". Water in the rivers was needed to

dilute pollution and improve water temperatures for fish, while people visiting the river for recreation wanted to see more water flowing. An unusual battle began between the Water Board and the River Board, all the more extraordinary because of the unremarked conflict of interest of Alderman Charles Allison, who was simultaneously not only Chairman of the Water Board but also Deputy Chairman of the River Board.

In 1953, and again in 1958, the Water Board promoted private bills (Tees Valley Water Bills) seeking temporary reductions in the compensation water. On both occasions, they were petitioned against by the Wear and Tees River Board, without success. Despite "several meetings between representatives of the River Board and the Water Board...unfortunately, no agreement was reached on the several points of difference" (Wear and Tees 1959). Alternatives to the Water Board's plans for further reservoirs in the dales were put forward by the River Board in 1955 but were rejected. (See below: "The Metropolitan solution").

After ensuring the necessary Parliamentary procedures, Julius Kennard oversaw the construction of Selset reservoir, acclaimed by the Water Board as an ample water supply for at least 25 years (Anon. 1955). Yet demand threatened to outstrip supply very soon after building started so that the Water Board wanted further dams.

The enticement of greater discharge encouraged Julius Kennard to stray from the Mansergh scheme, although two potential dam sites remained: at Balderhead above Blackton and at Blake House above Selset, and to investigate the possibilities of dams in the main valley of the Tees. The physical attributes of a large river flowing in a gorge were attractive but not only to an engineer: Upper Teesdale was contested territory. Beautiful scenery was valued by walkers, the dales' improved pastures were important for agriculture. Also most of the land had been designated by the Nature Conservancy as a Site of Special Scientific Interest (SSSI) and the bleakest upper reaches at Moor House had been bought in 1952 as a National Nature Reserve.

Julius Kennard sounded out the Nature Conservancy (NC) over potential dam sites. At first, the NC officers were not alarmed. They took their lead from much revered Professor W.H. Pearsall, F.R.S., who was interested in biological productivity more than preservation. As a member of the Conservancy since 1949, Chairman of the Conservancy's Science Policy Committee 1955-63, architect of the Upper Teesdale SSSI and the Conservancy's land use policy, he wrote to the Regional Officer:

> 'I think that it is pretty clear that from the point of view of the naturalists that the project of putting a dam just above Cauldron

> Snout is much the better one and I personally would offer no objection to it. I would not offer great objection to the alternative but I am pretty sure that there would be an outcry from the naturalists about this one. It is, between ourselves, logically and geologically the better site and I should not be at all surprised if ultimately adopted. (PRO FT 17/68, 08/05/56).'

But, in November 1956, Julius Kennard met with the Deputy Director, Dr Worthington, and was told that the NC might take strong exception to the reservoir. Worthington noted for the record that Julius Kennard was not interested in Natural History. (PRO FT 17/68 27/11/56).

The upper site above Cauldron Snout, Cow Green, was investigated first to test its geological suitability. The geologist, Edgar Morton, advised the Water Board that the site would not be watertight and should be abandoned. Attention turned to sites below Cauldron Snout, first at Holm Wath just below the cataract and then at Dine Holm further downstream, but above the waterfall at High Force, a major tourist attraction. Morton advised that the narrow valley with dramatic limestone cliffs at Dine Holm could, with some grouting, be suitable for an impounding reservoir. Water augmented by the reservoir could flow by gravity in a pipeline from an intake just below the waterfall to Teesside.

Alarm grew amongst scientists and amenity groups who feared loss of the rare flora, which had made Upper Teesdale internationally remarkable. At the same time as the Water Board was laying plans for a reservoir, an influential paper appeared in the Journal of Ecology (Pigott 1956) analysing why such a concentration of rare species found congenial conditions in Upper Teesdale, far from their usual habitats in high mountains or in the Arctic. The governing committee of the NC on 30/01/57(PRO), agreed "to make the strongest opposition to the proposed reservoir". A letter deploring the proposal was orchestrated for publication in the Times in February 1957, signed by 15 prominent botanists. The stakes had been raised from a local planning issue to a national debate both about nature protection and national policy for industrial water supply.

Communication between the Water Board and the NC appeared indirect at this stage. In July, it was a representative of Durham County Council who told the NC that the Water Board had now confirmed that it would be promoting a Parliamentary Bill in the next session for the construction of an impounding reservoir at Dine Holm (PRO FT17/68 18/07/57).

At last, on 8 October 1957, a meeting was held between the Water Board (Julius Kennard and E.A. Morris), the NC (R. J. Elliott), R. Atkinson

(Durham County Council) and J. Vincent (North Riding County Council). There was little meeting of minds. Elliott reported, "Pressed on the methods that the Board would adopt to meet a recurring water deficit - Kennard's only solution was 'additional reservoirs'…Asked what alternative sources of supplying industries' needs had been investigated - the officers (of the Water Board) present became decidedly hostile" (PRO FT17/68 08/10/57).

On 25 October, the Director-General of the NC, Max Nicholson, wrote "now that the Conservancy have instructed me to fight this Tees Valley case I will do so to the utmost of my ability, and am reasonably confident of success". He had been working behind the scenes, with the National Parks Commission, to tackle the Ministry of Housing and Local Government (MHLG). He recorded:

> 'The most interesting point of all which emerged was that the Ministry and the promoters have given no real thought or study to the alternatives and that they have at least at present no answer which could stand up to examination as to why the reservoir is necessary at Dine Holm or anywhere else (PRO 17/68 25/10/57).'

Then, Max Nicholson had an inspiration: rather than continuing to argue with the Water Board, or to hope that the MHLG would take action, he would approach the Chairman of ICI (1953-60), Sir Alexander Fleck KBE, FRS, DSc, directly. The letter amounted to refined blackmail,

> *'You are likely to be next year's President (of the British Association for the Advancement of Science) at Glasgow when, amongst other things, I understand that the question of water conservation is likely to be discussed...'*

He went on to alert Fleck to the threat of the Tees Valley Water Board "irretrievably to destroy this area by inundating it under a reservoir at Dine Holm" and concluded by saying, "we would be very sorry to find ourselves compelled to do battle with ICI without having made every effort previously to reach an acceptable solution" (PRO FT 17/68 01/11/57).

Faced with a potential humiliation on an occasion that should have marked the pinnacle of his scientific career, Fleck readily agreed to meet with Nicholson on 14 November 1957. Nicholson jubilantly reported back "the ICI were ready to put a brake on the Dine Holm project until there had been more opportunity to examine alternative sources of water."(PRO FT 17/68 14/11/57). ICI staff reported dryly on the Water Board's proposed bill:

> 'In view of the expected opposition from outside bodies to the scheme and incompleteness of the investigation of reasonable alternatives, ICI did not feel that they were in a position to support such a bill and this scheme was therefore shelved. (ICI X/11489).'

Julius Kennard reverted to the Mansergh plan for a third reservoir in Balderdale, above Hury and Blackton at Balderhead, despite opposition from farmers (Sheail, 1986), and an extension to the pumping station at Broken Scar. The Daily Express (8/4/61) reported the inauguration of construction at Balderhead and the passionate response of the Chairman of the Water Board who "was very cross about it all". Alderman Allison is reported to have said, "All this fuss is a lot of tommy rot. It is sickening to think that a little flower is more important than the future of Teesside. Who cares if the gentian disappears - it is no good to anyone?"

Meanwhile, the NC was lulled into complacency: the Dine Holm scheme had been averted and the potential reservoir site at Cow Green deemed unsuitable because of permeable rocks. A major flaw in the legal protection of Upper Teesdale remained: Moor House Nature Reserve had been purchased, a further National Nature Reserve had been agreed with the Earl of Strathmore west of the Tees but the land on the east, owned by the Raby estate, included Widdybank Fell with its valued Arctic-alpine vegetation still vulnerable as a "proposed" Nature Reserve with no legal status. The owner, the Hon H.J.N. Vane, later to inherit the title of Lord Barnard in 1964, did not want to comply with the NC's proposal for a nature reserve, perhaps because the barytes mines at Cow Green, closed in 1954, might be reopened should the market for this mineral recover.

To Julius Kennard, this unprotected site, barring the gloomy predictions of leakage by Edgar Morton, seemed more attractive than the last site identified by Mansergh higher up the Lune valley above Selset at Blake House. He sought a second opinion. His son, Michael, with Dr John Knill carried out a detailed site investigation from which they concluded that the high water table on the east side of Cow Green would prohibit leakage through the limestone strata to the adjacent Harwood Beck (Kennard & Knill 1969). With this good news, Julius Kennard recommended that steps be now taken for obtaining statutory powers to construct the reservoir.

The difficulties for the NC were just beginning. Julius Kennard approached them again in August 1964 (PRO FT 17/61 24/08/64) and was at first assured that the Cow Green site was unlikely to be problematic but in fact the proposal to build a reservoir at Cow Green unleashed angry reaction from naturalists in the Northumberland and Durham Naturalists Trust, the Botanical Society of the British Isles and many other environmental organisations. A public subscription was raised to fight the case and, following submission of a private bill in December 1965, the debate continued in the Select Committees of the House of Commons and the House of Lords throughout 1966. The story is told by Gregory (1975). This

time, Julius Kennard and the Water Board were victorious: the Board was granted permission by Parliament to build the Cow Green reservoir.

THE RISE OF THE MEGADAM

A decade later, in response to projections of increased industrial demand and in an attempt to avoid adding to the plethora of dales reservoirs, a tunnel was constructed to bring water 45 miles to the Tees from the river Tyne, supported by what was claimed to be the largest man-made lake in Europe, Kielder Water. This scheme made the Teesdale dams no longer essential. In theory, the Teesdale dams could now be decommissioned in favour of water imported from the Tyne. In practice, it is the giant Kielder reservoir with a capacity of 200 Mm^3, double that of all six Teesdale reservoirs, which has remained underused for 20 years, failing in its aim to improve the economic development of the North East by attracting new, water-needy industries. Supply from the Teesdale reservoirs continues as the cost of pumping water from the Tyne to the highest point of the Tyne-Tees tunnel is greater than the cost of supply by gravity flow from the Teesdale dams; also soft water from Lartington is economical for boiler feed. Only twice in its history has Kielder been used to transfer water to the Tees, first in 1983 and then in 1989, (FOE 2003) although water has been transferred as far as the Wear to supplement the underperformance of the Derwent reservoir (Soulsby *et al* 1999).

Planning water resources on such a large scale required political reorganisation. The Water Resources Act 1963 set the scene with the creation of large River Authorities and a national body, the Water Resources Board (WRB), to encourage long-term integration of water supply over wide areas. Rather than continued iteration with the industrial consumers to judge its effectiveness in promotion of economic development, dedicated focus on water supply made it an end in itself and safeguards against overinvestment were weak. Uncritical extrapolation of water demands at the outset was not corrected at later stages when British Steel failed to expand on Teesside. "Over investment for any particular area is indicated when facilities stand idle or else are put to makeshift uses, either to avoid the appearance of idleness or to minimize the losses due to past mistakes."(Hirshliefer *et al*(1960)). Tourism gains from Kielder may be viewed in this light. Short summers, high rainfall, biting insects, restrictions on motor boats and remoteness from centres of population suggest that such a recreational facility would not have been sited in the Upper Tyne valley, if this had been the main aim for such a huge financial investment.

Unlike the financial arrangements in Teesdale, those industries which demanded more water at the Kielder inquiry made little or no contribution to the capital costs of the Scheme, which was funded by loans from the

National Loans Fund £46M(£121M); from the European Investment Bank £63M(£166M) (at interest rates of up to 17 $^{7}/_{8}$ % over 25 years) and grants from the UK Government £24M(£63M) and the European Regional Development Fund £36M(£95M) (HoC Public Accounts 1984-85). Brady (1983) claimed that "the financial burden has shifted substantially away from Teesside industries towards the region's other consumers". In 1989, at privatisation, much of the outstanding debt was transferred to Government to make the sale of the Northumbrian Water undertaking attractive. Today, Northumbrian Water Group plc has debts of £1.7bn and receives £11.5M annually from the Environment Agency to operate Kielder (NSL Group 2003).

Environmentally, the assessment is mixed. Omission of a fish pass was justified at the time by substitution of a fish hatchery at Kielder and the hatchery has been successful in reintroducing salmon to the Tyne (Marshall, 1992). Yet there are serious doubts whether the genetic pool from which these stocks are bred is sufficiently diverse for the process to be sustainable (Anon 2002). Transmission of water from the Tees to the Yorkshire Ouse catchment is now physically possible via a pipeline constructed during the 1995 Yorkshire drought but such transfers are opposed by the FOE as dangerous biologically. Instead of importing water from another company, Yorkshire Water has improved conjunctive use of its own resources.

The high costs of the Kielder Water Scheme have weakened support for similar megaschemes. The words of Rocke (1980) ring true "schemes such as Kielder may be the last of their kind for some time".

A CENTURY OF DAM BUILDING FOR SUPPLY TO TEESSIDE: WINNERS AND LOSERS

Determined pursuit of water supply led by water engineers resulted in:

- Successful supply to Teesside industries and domestic users.
- Construction of six reservoirs in Teesdale, without oversupply because of control of funding by the industries benefiting.
- The second phase of 3 reservoirs in quick succession fuelled demands for longer-term planning and a national strategy.
- Expensive and protracted disputes, increasing distrust between water engineers and environmentalists.
- A greatly-modified river environment.
- The Cow Green reservoir, still regarded "as an unforgivable intrusion". (Ratcliffe, 2000). Valued vegetation was drowned and the surroundings affected (Huntley *et al*, 1998).
- The expensive and under-used Kielder Water Scheme, still a drain on the public purse.

Table 1. Impounding reservoirs in Teesdale, also Kielder Water

Reservoir & consulting engineer	**Date built. River**	**Dam dimensions**	**Full Capacity**	**Type**
Hury *J. Mansergh*	1894 Balder	33m H 374m L	3.9Mm^3	Direct soft water supply
Blackton *J.Mansergh*	1896 Balder	21m H 338m L	2.1Mm^3	To Hury + flood bypass.
Grassholme *E Mansergh*	1914 Lune	34m H 274m L	6.1Mm^3	Compensation + to Hury.
Selset *J.Kennard*	1959 Lune	41m H 928m L	15.3Mm^3	To Grassholme
Dine Holm	*Abandoned Tees*		*17.2Mm^3*	*Direct*
Balderhead *J.Kennard*	1964 Balder	52m H 914m L	19.7Mm^3	To Hury + regulating
Cow Green *M.Kennard*	1970 Tees	26m H 572m L	40.9Mm^3	Regulating
Kielder *D.J. Coats*	1982 N. Tyne	52m H 1140m L	200.0Mm^3	Regulating

(See Note 3)

AN ALTERNATIVE WATER ENVIRONMENT**.**

More use of groundwater, demand reduction by improvement of industrial efficiency in energy use, water recycling and elimination of polluting discharges are some of the alternatives raised by critics of this century of impounding dam construction (Kinnersley 1988; Pearce 1982). The quantities of water required might not have been met wholly by such means but a concept raised during the struggles, perhaps too easily dismissed by the water engineers intent on upland dams, is worth revisiting in the light of modern ambitions, such as those raised in the European Water Framework Directive. This was called the Metropolitan solution, basically reducing the spatial extent of the "footprint" of industrial Teesside, following the example of London.

THE METROPOLITAN SOLUTION

Cecil Clay, Chief Engineer of the Wear and Tees River Board, put forward plans more protective of the integrity of the Tees. He suggested conjunctive use of abstraction at Broken Scar with storage in the three existing upland reservoirs and seasonal variation in release of compensation water (HoC 1958). His ideas were supported by Thomas Hawkesley, great grandson of the first engineer of the private Middlesbrough and Stockton Water

Company, who added that water abstracted at Broken Scar would need more treatment and pumping than the upland water but the extra cost would be "a bagatelle on the total annual cost of the undertaking"(HoC 1958) (17). Later, the River Board put forward a plan to the Water Board that added pumped storage reservoir(s) in the Tees lowland to store river water abstracted at Broken Scar or nearby points during high flows. Six possible sites were proposed as shown on the map (Figure 1).

This "Metropolitan" solution, similar to London's supply, with water abstracted from the Thames and stored in large off-river reservoirs at Windsor and Staines, was turned down by the Water Board before they promoted the Cow Green scheme in Upper Teesdale in 1965. Julius Kennard (1965) advised the Board "we are in no doubt that such a scheme should not even be contemplated in the circumstances". He argued that the capacity of the abstraction plant at Broken Scar would have to be extended if high flows were to be abstracted and taken into storage and suggested that a pumped storage scheme might take longer to construct than the Cow Green reservoir. However, it is debatable whether construction in the lowlands would take longer than construction of Cow Green in the Pennines, where the construction season was short because of heavy snowfalls.

A pumped storage reservoir built at about the same time for London's water supply, Wraysbury ($35Mm^3$), provides a comparator with Cow Green ($40Mm^3$). Wraysbury took 5 years to build, (1965-70), and cost £3.7M (£35.2M). Cow Green took 3 years to build (1967-70) and cost £2.5M (£28.6M) (Griffiths 1984). Yet Kennard claimed: "the cost of the reservoir (pumped storage at Teesside) itself could be as much as twice the cost of Cow Green reservoir". WRB (1965) thought two of the six Teesside sites were comparable with Cow Green: at Staindale, and at Cowpen on the estuarine marshes where the building estimate was equivalent to that of Wraysbury, even though costs of construction and land purchase in Teesside were likely to be much less than those in the desirable London suburbs. Other potential problems were listed, none of which deterred the engineers constructing similar off-river reservoirs at London, Farmoor (Oxford) and Exeter. The case was concluded by anticipation of great opposition from the public; in fact, it was the underestimated opposition to the upland Cow Green reservoir that caused two years' delay.

The multiplicity of arguments made against the Metropolitan solution gives an impression of special pleading. Some could be countered; for example one of the sites, on Cowpen Marsh, was not good agricultural land. Even the loss of good farmland did not prevent the building in the area of many service reservoirs for the Teesside distribution network. One of these, the

Long Newton reservoir at 200 ha, a third of the possible size of a pumped storage reservoir, was constructed without opposition, only two miles south of one of the proposed sites at Newbigin. Even if the costs were somewhat higher, reservoir construction near a city offered much needed water-recreation facilities within easy reach of many and, probably, less upset for any families displaced by compulsory purchase because of the greater availability of job opportunities in a suburban area and greater acceptance of industrial development by the public.

The botanist, Professor Donald Pigott (1957), summarised the situation:

> 'The continual expansion of British industry results inevitably in an increasingly urgent competition for space in this crowded island. This would be less serious if industrialisation could be confined to certain agreed areas. But enormous quantities of water are demanded for modern industrial processes and this leads to constant requests for permission to construct reservoirs at points well outside the actual industrial regions.'

If the alternative of off-river pumped-storage schemes had been opened up to public debate, the outcome of the struggles for water in Teesdale might have been very different with habitats of rare plants left unmolested.

CONCLUSION.

A century of industrial expansion in Teesside began with laws requiring compensation for water withdrawn from rivers or for injury to game fish populations and it was a criminal offence to pollute water. Each of these ideals was eroded under pressure, as illustrated in this story but now, with the decline of heavy manufacturing industry in Europe (often re-located overseas to even more water-stressed environments), hopes of an undamaged water environment have returned.

The challenges presented by the European Water Framework Directive will require cooperation rather than the antagonism between engineers and biologists that marred the era of industrial expansion. If the new legislation is to be more successful than the old, many water resource solutions, structural and non-structural, need to be explored before attitudes harden around preferred options. Historical studies of the connections between politics and the environment may illuminate scenario building for a future requiring holistic responses.

ACKNOWLEDGEMENTS

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NOTES

1. Money has been translated into 2002 purchasing power by Economic History Services www.eh.net/hmit/ppowerbp/
2. In Mansergh's words, reflecting on common law, "no public body may abstract water from a surface stream (other than a large river at a low level) without compensating the owners below, either in money or in water…Further, no riparian may pollute a stream as it passes through his estate, or take water so as to reduce its volume except for fair and legitimate uses upon that estate" (1901).
3. Hury, Blackton and Grassholme engineered by J. Mansergh & Son; Selset and Balderhead by Sandeman, Kennard & Pts; Cow Green by Rofe, Kennard & Lapworth; Kielder by Babtie, Shaw & Morton.

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SESSION 1
BENEFITS AND SOCIAL IMPACTS OF RESERVOIRS

Chairman Jim Millmore
Technical Reporter Ian Scholefield

Papers Presented

1. The benefit of dams to society
   C Binnie

2. Lake Hood – creating waves in the community
   GA Lovell

3. Balancing the costs and benefits of dams: an environmental perspective
   U Collier

4. Follow up to the WCD report – where has it gone?
   J Bird

Papers not Presented

1. Political ecology of dams in Teesdale
   C McCulloch

Rod Bridle (Independent Consultant)
Question to Ute Collier, WWF International. In your paper you say, and I have heard your director say the same, that 'the loss of freshwater biodiversity continues at a rapid pace. Dams are a major culprit in this process'. You also say that the WWF's Living Planet Report shows that 'the world is currently undergoing a very rapid loss of biodiversity'. However, the evidence you present in Figure 1 and in the paper (correctly taken from the Living Planet Report) relates only to *populations* of indicator species in rivers. There is no evidence about losses, or gains, in the numbers of different *species*. Species numbers are the parameter against which bio-diversity is measured. Consequently there is no evidence about loss, or gain, in bio-diversity, nor whether it is rapid, slow or static. There is also no specific evidence that dams affected the populations. Many factors other than dams affect the conditions in rivers, notably pollution. In view of these fundamental misinterpretations of the ecological evidence, will WWF withdraw their opposition to dams, and apologise to the world community for the part they have played in depriving so many of the benefits of dams?

Dr Ute Collier (WWF International)
First of all, if you read any of our publications including the recent report, our website and our ad carefully we never say that the WWF opposes dams, and how can we oppose dams when we work with government to improve dams? It's not about opposition, it's about better planning, better resource management. This is my first point.

I have to take issue with you saying that we're depriving people of the benefits but ok that might be your opinion. On the biodiversity issue specifically, the reason the Living Planet Index uses indicator species is because there is no global assessment of all freshwater species

so we have to take indicator species. Population size is important. I think there is plenty of evidence out there about species extinction and about reductions of in species numbers. This is just not WWF's work. I could probably provide you with a huge number of academic papers etc. There is no doubt that we do have a global environmental problem of species extinction and bio-diversity being affected. I think its pointless denying it. The point we should focus on here and all work towards, is to deal better with the threats. There are certain places where we just shouldn't have a dam because it would affect biodiversity and wipe out some species, while other places are less of a problem. It is thus a matter of planning properly.

Rod Bridle (Independent Consultant)
Post conference contribution on same paper, responding to points made in reply to my question:

In spite of Dr Collier's assertions to the contrary, the paper shows that WWF do obstruct dams. The paper does not mention that they also obstruct them in the early stages, particularly when finance for them is being sought; by attacking the reputation of would-be investors suggesting that investment in dams is unethical, thereby undermining the organisation by weakening its share value. The pernicious and inverted sense of values that underlies such actions was summarised by one dam owner at a most distasteful meeting I attended. He asked why his reputation should be at risk if he tried to help people in need? He, like most of us, expected to be vilified for failing to help people, not for trying to.

Dr Collier offered to provide references that do support the WWF claim that dams are a major culprit in the loss of freshwater biodiversity, that is to say, a loss of species; I hope she will do so. However, I doubt if there are any that demonstrate the point as definitely as she and her director assert. On this matter it seems that fact is stranger than fiction, as I learned at the environmental symposium at ICOLD in Seoul. I was struck by the increasingly sophisticated modelling of natural processes that is now available, in sedimentation and sediment flushing, for example. Forecasting tools seem to be lacking in ecology, however. Dr Collier made the same presentation with its unfounded assertions about loss of bio-diversity, and the lead ecologist from the World Bank provided a checklist for site selection. We need some 'ecological engineering' to predict likely outcomes of new projects, and it was a pleasure and a surprise to hear a paper from Sweden (Svenson, Bjorn S (2004) Dams & biodiversity: management options and constraints. Proceedings, symposium on environmental considerations for sustainable dam projects, ICOLD 72nd annual meeting, Seoul, Korea) that showed how numbers of fish species could often increase after a dam was built, apparently because the more modulated environment favoured a wider range of species than the pre-dam one. On hearing this, the person responsible for environmental matters at Itaipu dam in Brazil told us that there they had counted more species now than before the dam was built, but had not broadcast the information because it was so against their expectations, presumably conditioned by years of anti-dam propaganda, that they had thought that there must have been a mistake in the original count!

WWF's objections to dams may have started from legitimate concerns, but they have not been properly supported by scientific evidence, and are now based on their *beliefs* about the environmental impacts. Beliefs do not make dams stand up, nor do they help to predict and mitigate environmental effects. Engineers have to make responsible enumerated forecasts about all aspects of their projects. WWF will not help us to do this. They, and their co-

believers in many organisations from Friends of the Earth and many other NGOs through to the Environment Agency and CIWEM, preach in varying degrees that cataclysm is near and have intimidated much of society into accepting their view, sometimes to the extent that legislation based on the beliefs is in place.

The impacts of these beliefs, which are now often presented as 'sustainability', are borne by society. In the developing world they lead to the deprivations highlighted by the Millennium Development Goals, such as the 800 million people who are malnourished. In the developed world, because WWF and their co-believers have projected beliefs that clean nuclear and hydro-power damage the environment, the beliefs have led to an over- dependence on fossil fuels which is threatening us all with the only possibly cataclysmic anthropomorphic environmental threat, the rapid onset of climate change.

Civil engineers and their colleagues in infrastructure services will overcome these problems sustainably by the responsible appliance of science and technology to meet society's needs. It is interesting how at our conference we have enumerated both the benefits society enjoys from dam infrastructure and the risks to society from dam failure. We are now at a position where we are asking society, through its elected leaders, to make decisions on acceptable levels of risk by taking a view on behalf of society at large on the costs the benefiting community should be expected to bear to provide sufficient safeguards to the downstream community at risk.

Dr Ute Collier (WWF International)
Response to Rod Bridle's post conference contribution

1. Species, species populations and biodiversity

According to the United Nations Convention on Biological Diversity, biodiversity means 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'.

The general interpretation of biodiversity is on three levels:
- in terms of the variety of plants, animals and micro-organisms (eg. number of species)
- in terms of genetic differences within each species (eg. size and resulting genetic diversity of a species' population)
- in terms of the variety of ecosystems.

So, if populations of species are lost in one river (thus reducing the genetic diversity and diversity within ecosystems), this undoubtedly constitutes a loss of biodiversity, even though the species may survive in a different river.

2. Evidence of impacts of dams on species

There is considerable scientific evidence that dams have caused both species extinctions and reductions in species populations. A thorough review of the ecosystem impacts of large dams was conducted for the World Commission on Dams (see http://www.dams.org/kbase/thematic/tr21.htm) based on contributions from scientists from leading institutions, including a number of UK institutions: the Institute of Hydrology (now Centre for Ecology and Hydrology Wallingford), Universities of Liverpool and York, and the Natural Resources Institute (University of Greenwich). This review extensively quotes peer reviewed scientific papers on this theme. For example, the paper by McAllister et al on the biodiversity impacts of large dams quotes 150 or so references, the majority of which are scientific papers from journals or conference proceeding and most of them report negative impacts on biodiversity.

It is particularly important to note that reservoirs create a different type of habitat from fast flowing rivers, thus suited to different species (i.e. those that like still, impounded waters rather than fast moving rivers). This does not contribute to biodiversity conservation since: a) it is the species adapted to fast moving rivers that are at most risk of extinction from habitat loss and barriers to migration caused by dams, and b) the fish adapted to lakes and dams are often common species, and even exotic to a particular river, and so do not add to and may further threaten aquatic species conservation.

3. Fish and dams

One paper for the WCD thematic review, written by Donald Jackson, Professor Wildlife and Fisheries, Mississippi State University USA and Gerd Marmulla, Fishery Resources Officer, Food and Agricultural Organisation, specifically focused on the impacts of dams on river fisheries. It concludes as follows:

'From a fishery perspective, dams and their resulting reservoirs can benefit human societies. Dams, however, usually alter traditional riverine fisheries, sometimes positively (ie, from tailwater fisheries), but more commonly negatively. There typically are faunal shifts from

river-adapted species to those more adapted to lentic environments. Species diversity in impoundments usually declines over time as river-adapted species fade from the system. Benefits from impoundment of rivers seem to be more pronounced for smaller, shallower reservoirs that have reasonably high concentrations of dissolved solids and that are located in the upper reaches of their respective river ecosystem. However, several such impoundments within the same river catchment can result in synergistic negative impacts to the downstream fisheries.' (http://www.dams.org/docs/kbase/contrib/env243.pdf).

The paper by Svensson (2004) quoted by Rodney Bridle is not entirely positive about the impacts of river regulation either. It states that "It should be noted that positive experiences of weir constructions are not universal. In floodplain, rivers and to some extent also in braided rivers, weirs might reinforce the negative impact of regulating dams". Furthermore, it says that 'Sometimes, the local extinction of species is an inevitable outcome of river regulation but all too often incapability or lack of management instruments lead to this unfortunate consequence'. This is exactly the point I was making in my paper and it is universally accepted that effective mitigation measures are an important tool for addressing biodiversity impacts.

As regards the increase in fish species at the Itaipu dam, it is not true that this information has not been made public. In fact, one scientific paper was published in 1994 (Agostinho, A.A., Julio, Jr., H.F. & Petrere, M. 1994. Itaipu Reservoir (Brazil): Impacts of the impoundment on the fish fauna and fisheries. pp. 171-184. *In:* I.G. Cowx. (Editor)*Rehabilitation of freshwater fisheries.* Fishing News Books, Oxford.) However, as Agostinho has also found in another paper: 'Before the construction of the reservoir, artisanal fisheries were based on a more specialized and more profitable fishing method, using baited hooks to catch large migratory piscivores (about ten species, in general reofilic). The lacustrine conditions, found in the reservoir, have caused a depletion of large piscivores stocks and an increased density of piranhas (*Serrasalmus marginatus*), which eat the bait. This compels the fishers to use gillnets, increasing both the numbers of species exploited and the amount of by-catch' (http://www.worldfish.org/Blue%20Millennium%20PDFs/Chapter%202-%20Agostinho%20and%20Gomes%20Case%20Study.pdf).

WWF accepts that dams do not always have a negative effect on fisheries or indeed fish diversity. However, the overwhelming scientific evidence is one of more negative than positive effects.

1. Intimidation of society

WWF's mission is to stop the degradation of the planet's natural environment, and to build a future in which humans live in harmony with nature. We are a charity dependent on 5 million supporters worldwide. We pride ourselves on being constructive and science-based. People make up their own mind on environmental issues – intimidation is not a method we employ.

2. The Millennium Development Goals(MDGs) and environmental protection

The Millennium Development goals emanate from the UN Millennium Development declaration which specifically recognised the interlinkages between environment and poverty and stated that 'we must spare no effort to free all of humanity, and above all our children and grandchildren, from the threat of living on a planet irredeemably spoilt by human activities, and whose resources would no longer be sufficient for their needs'. Environmental degradation (such as deforestation and overexploitation of water resources) is a major cause

of poverty and hunger. WWF and many other NGOs are trying to address these problems and are actively involved in ensuring the delivery of the MDGs.

6. Over-dependence on fossil fuels

In the developed world, the potential for additional hydropower development is limited. According to the International Hydropower Association, Europe has developed 75 % of its technical and economic potential, while North America has developed 69%. For the remaining potential, social and environmental factors have to be weighed up with the CO_2 reduction benefits of hydropower. Which of this remaining potential is to be developed is not a decision for engineers alone – governments, with input from civil society, will make the ultimate decision.

Nuclear power can hardly be described as clean when no long-term solution for radioactive waste disposal has been found. Furthermore, in the UK it has been economics rather than environmental concerns that have stopped the expansion of nuclear power.

WWF believes that climate change is a real and immediate threat and is campaigning to reduce the use of fossil fuels. Hydropower has a role to play in emission abatement but should comply with the recommendations of the World Commission on Dams.

(The above discussion was brought to a close at this point)

Cassio Viotti (Chairman of ICOLD)
Comment on follow up to the WCD report – where has it gone?

J Bird commented that there have been comments on the balance of the global review of dams done by the WCD. I want to say that ICOLD considers this review was definitely biased, and that recognition of that fact would be beneficial to the dialogue between ICOLD and other people interested in the subject.

Jeremy Bird (Independent Consultant)
Response to Cassio Viotti.

I'd just like to repeat that I'm encouraged at the new approach taken by ICOLD now and the Global Review, I know, as I mentioned, a number of organisations made that comment. I'd also like to point out that the issues that were raised in the Global Review, regardless of the numbers, do reflect a number of independent evaluations done by other authorities. I've looked at the World Bank operations evaluation division review of 50 dams, ADB at the time of looking the WCD's operation did a review of 10 hydropower projects and also a more in-depth review of 4 projects from China, Laos, Sri Lanka and the Philippines. In those many of the same findings came forward, maybe not in the same way that they were presented in the Global Review. So I think that regardless of whether you're on the side that says the Global Review was biased or whether you're saying no it is a true reflection, the issues are there and I think that those issues still need to be dealt with. Many changes have been implemented as a result of a number of these studies and lessons have been learned in moving forward so I just feel very, very pleased because when the report did come out even the ICOLD website was extremely negative, not only about the WCD report itself but also about the UNEP-DDP project. I'm now pleased that that situation has changed.

Professor Luis Berga
Question to Ute Collier, WWF International - Balancing the costs and benefits of dams: an environmental perspective

Congratulations to Ms Collier for this presentation but the paper is very different from the presentation. The presentation said that the Directive of the European Union is almost superficial, European countries have almost 10 years or 11 years to comply with the ecological state of our waters but in the paper you propose and support so strongly the implementation of the World Commission report in Europe. I think that the first question, by what means will the implementation of the World Commission report be carried out in Europe? And the second, I feel that we have sufficient directives in Europe. My feeling is that this report is a complication – do you want to complicate the water resources in Europe or water resources management?

Dr Ute Collier WWF International
Response to Professor Luis Berga

We actually had a Spanish environmental lawyer analyse the Water Framework Directive versus the recommendations of the World Commission on Dams and she found very many similarities, not surprisingly because the two were conceived during the same time. When you say things are out of date now because they're from the late 1990's, do you mean that things like river basin planning are out of date? When we talk about implementation of the recommendations you could also say application of the recommendations if you like. It's very much as Jeremy says, it's not a blueprint it's about reviewing your legislation, your general decision-making frameworks to see what changes are needed to come to a better decision-making. So what we're suggesting, and I will give you the paper later on, is for example in the Water Framework Directive which is a framework with a number of guidance documents, we think a lot can still be learned on issues like public acceptance, where the World Commission went much further than the Water Framework Directive because they were focussing on different issues. We're suggesting there could be recommendations in there that could be applied in a European context but it has to be nationally applied.

Professor Luis Berga
Question to Jeremy Bird, Independent Consultant – Follow up to the WCD report – where has it gone?

I think that one of the problems of the World Commission report is that nobody supports it. I was in South Africa in the World Commission on Dams Forum and the Forum of the Commission did not support the report and there was no agreement within that Forum in their elaboration of the report. The report is a good report but it was elaborated from the Commissioners, there was no participation of the Forum of that report. Another point, the World Bank, one of the founders of the World Commission, does not support the report. You know very well that the problem is the application of the WCD report and no country in the world supports the application of the report. Why? I think that the report is made in the late 1990's and the world has changed a lot and the World Bank, United Nations and all people speak louder about the core values of the report but we need sustainable development and many people think that this World Commission report is against the sustainable development.

Jeremy Bird
Response to Professor Luis Berga.

But first of all Professor Berga I think some of the comments you made were rather sweeping and general in nature. There were 2 or 3 issues that you raised. First of all the role of the Forum. The Forum was a body which actually started off life as a workshop and asked for the

Commission to be established and then became a sounding board for the Commission during its life and of the 1,000 or so different pieces of information, case studies and reviews, submissions that were made, Forum members individually and collectively made a tremendous input. So I think in terms of creating that knowledge base from which the Commissioners made their decisions, the Forum had a very strong role. But let's remember that the Commission was a body of 12, an independent body, it was 12 individuals. It wasn't set up by the UN, it wasn't answerable to the Forum in any way. And the Commission's report is the result of those deliberations, so the Forum never had the mandate to approve or disapprove of the report. At its final meeting the WCD Forum did, by general consensus even though there were some dissenting views, agree to this follow-up process that UNEP has now coordinated, so I think in that sense I disagree that the Forum has a body did not approve the report. I don't think that it was ever asked of them to do so.

I think one of the other issues was about the World Bank. The World Bank Board of Directors have put on their website their official position which is to approve or to endorse the 5 core values and the 7 strategic priorities of the report and as you say they also raise a number of questions regarding the implementation of its guidelines. But let's take options assessments for instance, the World Bank has actually adopted many of the more detailed principles in the report in their Sourcebook on Stakeholders Involvement in options assessment. But there are other issues I know regarding prior informed consent for indigenous people, regarding the stakeholder forum and on public acceptance which World Bank staff will argue very strongly against. The Asian Development Bank in their response made an assessment of the report and said that already they were following 17 of the 26 guidelines, so I don't think that can really be characterised as a rejection of the report. And I think more and more private sector organisations recognise the importance of the report, Swiss Re – the insurance company for instance, basically says in their document on dams, it would be inadvisable for any organisation to go now into a dam project without at least reviewing and addressing the issues raised in the report.

I'm afraid my take-on this is a little bit different from yours but I know there are many, many different views. And one more we should just finalise before the chair cuts me off completely is China. China was said to have rejected the report and at a meeting in Manila in 2001 came very strongly against the report because they thought that World Bank and Asian Development Bank were simply going to slap their covers onto it and say that this is the new safeguard policy of the banks. Once they realised that was not the case and that it was going to be used as a vehicle for discussion and articulation of some of these concepts, they then started to engage in the follow-up process and now both the Ministry of Water Resources of China and the State Environment Protection Agency are members of this new forum, the Dams and Development Forum coordinated by UNEP.

Dr Trevor Turpin - Nicholas Pearson Associates
General comment on session 1 of the conference.

As an environmentalist, I believe that the BDS should be complimented for opening the conference with this (to some) controversial topic and for the selection of papers. I would particularly commend the inclusion of the paper by McCulloch: the Cow Green reservoir marked a turning point in terms of dam and reservoir design, promotion and construction. However I felt that the aggressive nature of some of the questioning at the conference did little to advance a spirit of cooperation between environmentalists and engineers.

I noted in particular in these papers that the topic of 'sustainability' was not mentioned and since Sustainable Development is at the root of and embedded in UK Government planning, this seems to be an omission. Finally, BDS has set the agenda for the follow up to WCD as discussed by Jeremy Bird and I wonder if BDS should now be promoting a continuing debate on the topic – perhaps combined with the principles of sustainability?

Form B's submitted after Session

Jim Prentice (Northumbrian Water)
Post conference comment on Christine McCulloch's paper 'Political Ecology of dams in Teesdale that was not presented at the conference.

The paper was not presented at the conference so thanks are due to Christine McCulloch for her work to incorporate the text within the conference book

As the operator of the resources within Northumbrian Water there are understandably some points of detail and some fundamental factual inaccuracies within her note prepared as she did not make contact with me. I hope to concisely add to her note and present a correct understanding of the Teesdale and Northumbrian systems - as Kielder has crept southwards into her note.

The first formal abstraction works commenced operating in 1849 taking water from the river Tees for the benefit of Darlington's 11000 population - a growing and prosperous railway town (population 8574 in 1831). The close political links with the small but rapidly growing towns of Stockton and Middlesbrough (154 population in 1831 and 12000 by 1849) allowed connection to the 1849 works in 1851; later a separate water undertaking was arranged in 1853 and led eventually to 6 steam beam engines at Broken Scar with 4 engines still supplying up to 35Mld in 1953. The adjacent Cleveland Water Co. was using an upland reservoir at Lockwood for their demand zones up to 8Km from the dam and comparison was inevitable with the river abstracted water used in the Tees Valley. The Cleveland Hills and other nearby sources were investigated for use in the Tees Valley but sufficient yield could not be achieved and Teesdale was chosen for the dam sites some 60Km from the demand. The Water Board was formed and as expected the financial stress imposed from buying out the Company (originally expected at about £550,000 and later paid £800,000 – the largest cheque cashed in the world up to that time) did not allow Teesdale dam building investment to commence until late 1880's.

The result was the supply reservoir at Hury which allowed piped upland water to be treated at Broken Scar by 1894 and the compensation reservoir at Blackton to be completed by 1896 along with the intermediate Hury Subsidiary dam allowing compensation water to enter the Hury bypass channel and so to the river. Treatment works were not built at Lartington until 1903. Grassholme dam was built by 1914 to compensate the river Lune for the construction immediately upstream of Selset Weir which allowed the river Lune flow to be transferred by tunnel into Hury reservoir and so to Lartington treatment works.

The groundwater in the Tees area relies on inflow to the Permian Limestone, Bunter Sandstone and Keuper Marl and is limited to about 36Mld; however the full inflow would be difficult to abstract. Groundwater investigations were undertaken in the late 19th century and the borings under Middlesbrough found saline water and also the extensive salt deposits

around the Tees estuary which directly led to the chlorine based chemical industries, particularly Brunner and Mond, the forerunners of ICI, being located there. Surface water sources were the only ones able to supply the growing domestic and industrial demands.

The step increases of yield in the Lune and Balder valleys were restricted after Selset was built as the 'best' reservoir sites were already occupied. Cow Green offered the opportunity to make better use of the Tees catchment to Broken Scar by using a river regulating policy and making best use of rainfall events resulting in a smaller reservoir than the equivalent direct supply reservoir. The area around Cow Green mine was despoiled by the mine operations and it is only in more recent times that the tip heaps have succumbed to nature The photographs taken in the mine area prior to the dam being built revealed a typical ramshackled arrangement with no regard paid at all to the environment. However the funding (£100 000) given by ICI for environmental research allowed disproportionate effort to be focussed into the Cow Green area and so many reports were published without addressing Teesdale's environmental diversity even as close as the adjacent Harwood and Langdon Valleys. A distorted view of Cow Green's biodiversity resulted and species classed as special to Cow Green environs can be found elsewhere in Teesdale.

The benefits of a regulated river can be discussed elsewhere but an illustration of low summer flows are clear from a set of photographs I have, taken from the Tees source and ending at Broken Scar during about 1 week in June 1933. This was not a drought year but Cauldron Snout (the highest water cascade in England) was a cascade of rocks with occasional glimpses of water while High Force (the highest single drop waterfall in England) appeared as pencil thin streams of water droplets of about 0.3cumecs. This compares to the Tees today when High Force has a drought period flow of some 8 cumecs – not a huge flow but does present waterfalls with flowing water!

The Kielder Scheme was the next step in resource development related to the Tees system although it was a regional scheme for the benefit of most of Northumbria. The comment that the Kielder Scheme made the Teesdale dam 'no longer essential' is perhaps grammatically correct but linked with the theoretical decommissioning of the Teesdale dams paints a picture that the Teesdale dams should no longer be used! However, since the Kielder scheme has been built, we minimise the operational spend and quite correctly use the cheapest sources first and these are the gravity systems within the Tees Valley. The transfer of Tyne water to the Tees has not occurred frequently but Kielder system is used to support the Tees every drier than average year. The operation of the Tees system (and other Northumbrian reservoirs) allows for use of Tyne water and so reservoirs such as Cow Green can be drawn down further than could possibly be permitted had the Tyne Tees transfer not been available at the 'push of a button'.

A 'Metropolitan' system using off-river lowland storages would require storage to replace Cow Green of 60 Mm^3 with probably three reservoirs of 10Mm^3, 25Mm^3 and 25Mm^3 taking up some 6sq.Km. of land and embankment length of about 16Km. involving some 8Mm^3 of embankment material!! Considerably more expensive both of land and finance than the provision of Cow Green dam. The Tees in summer is a much lower flowing river compared to the Thames and for much of even normal summer abstractions could not take place without river regulation unless the flows to the estuary could be much lower than they are now. The flow over Thames' Teddington weir is many times greater than the Tees' natural summer flow of 1.25 cumec and drought natural flow of 0.6cumec – abstraction would not be possible without reservoir releases!

The political ecology of dams in Teesdale is presented in Christine McCulloch's paper quite differently to the Board Minutes from 1876 and maybe a balanced viewpoint is somewhere between the two sources. The Board minutes indicate a calmer approach to the dam development with well reasoned responses to environmental aspects and Alderman Allison's tommy rot reference cannot be found!

Christine McCulloch (Oxford University)
Reply to Jim Prentice's post conference comment.

The purpose of my paper on the political ecology of dams in Teesdale is to illustrate the political nature of decisions to build dams at particular sites at particular times, rather than repeating a technical history already covered by Jim Prentice in Dams and Reservoirs (January 2003 v 13(1) pp.19-24). My proposition is that no single engineering rationale determines one inevitable solution to water supply by reservoir construction. Rather, many social factors influence events, as I have demonstrated. Perhaps broader awareness of the context of dam building beyond its technicalities may help engineers to avoid the dilemma of the rueful surgeon who could claim that "The operation was a success; pity the patient died"!

Jim Prentice adds some supplementary information but without contradicting the import of my interpretation. Indeed, I fail to understand why he appears so annoyed and aggressive. I have compared my paper with his comments and cannot find any "fundamental factual inaccuracies". The engineering and ecological aspects were checked with professionals before publication. I did consult Northumbrian Water during my research but, rather than being advised to contact Jim Prentice, I was directed to one of his senior colleagues, who kindly escorted me on a visit to Kielder.

I did not claim that Alderman Allison's remarks were recorded in the Tees Valley and Cleveland Water Board minutes; the minutes are brief, boring and written to justify the decisions made. The Board's actual discourse occasionally leaked out, however. In March 1965, as the Cow Green dispute was brewing, the Wildlife Observer claimed that, "At a recent meeting of the Board, one member described the naturalists as irritating, to which another is reported to have said, 'No more than a flea and that can have DDT put on it'". The Director General of the Nature Conservancy was so stung by this report that he wrote to the Secretary of the Board to complain that, "The utmost difficulty and embarrassment has been caused to the Conservancy by publicity arising from the Board and if this case is to be handled in an orderly and reasonable manner, I must request your Board and all its members individually treat the subject as *sub judice* and abstain from any comments which might raise public controversy". (Public Record Office, FT17/61). In research of this kind, it is important to draw on many sources.

The "Metropolitan solution" was discussed by engineers at the time of the Cow Green promotion as stated in my account. Interestingly, in 1975, the issue was raised again in discussion of Burston and Coats' paper on the Kielder Water Scheme (J. Inst. Water Engs. and Sci. v.29 pp.248-251), when Mr E.C. Reed of Thames Water Authority pointed out the advantages of storage in lowland areas, despite the tendency in the UK to pursue storage involving reservoirs high up river systems.

When, during the Second World War, committees were thinking long and hard about what qualities of life in Britain were worth defending or improving in the post war era, the

exceptional value of the flora and fauna of Upper Teesdale was recognised. Intrusion of the Cow Green reservoir into the area of arctic-alpine vegetation is still sorely regretted by botanists. The full range of edaphic conditions supporting the vegetation down to the banks of the Tees will now never be fully understood. Jim Prentice does not make clear how he has come to believe that biologists have come to a distorted view of Cow Green's biodiversity. It was not claimed that the plants were rare on a continental scale; if you go to Arctic Finland, for example, they occur in abundance. The puzzle is how they flourished at such low altitude and latitude.

In decrying the "disproportionate effort" of environmental researchers on the Cow Green area, Jim Prentice makes a strong case for ignorance: it is much easier to harm the environment if there is no knowledge of what may be lost or damaged. The donation of ICI may have helped to restore its reputation amongst the Northern Universities on which it was dependent for research ideas and staff recruitment but did not stretch far in funding environmental research. Most of the research on Upper Teesdale has been funded by the Natural Environment Research Council, after careful scrutiny and peer review.

Jim Prentice is right in pointing out the snowball effect of development in a cherished area. The mine at Cow Green for barytes, used in bombs, did not disturb a large area of the interesting vegetation but its access road was an important part of the case for constructing the reservoir there rather than using an alternative, but roadless, site in the neighbouring valley of the Maize Beck.

I endeavour to write balanced accounts, giving both sides of the debate. I hope that Jim Prentice's over-defensive attitude is not widely shared amongst dam engineers. There is a great deal of interest in the story of British dams, which have made such significant changes to our landscape and economy and much fascinating research remains to be done. I trust that the friendship I have experienced in the British Dam Society will continue to enable me to gain insights and to discuss my findings freely.

Colin Hunt (Bristol Water)
Question to Ute Collier

If you could remove one major dam structure in the UK to improve the freshwater aquatic eco system which dam would you choose and what would you envisage the changes would be?

Dr Ute Collier (WWF International)
Response to Colin Hunt

I'm sorry but I can't directly answer this question as I'm not very familiar with the situation in the UK (my remit is a global one and my UK colleagues have not advocated the removal of any dams in the UK). WWF has only promoted dam removal in a few cases, such as the Poutes-Monistrol dam on a tributary of the Loire river which has been identified as a major obstacle to the survival of one of the Loire Atlantic salmon (reduced from 30,000 to 1,000 individuals). Generally, we promote less drastic action (i.e. mitigation measures such as an environmental flow regime) but there are cases where dam removal is the best option for ensuring the survival of migratory fish species or an important wetland habitat. Clearly, in each case the environmental benefits have to be weighed up with economic or social issues.

Colin Hunt (Bristol Water)
Open question to all Panel Members

With ever increasing pressures to restrict costs to a minimum on major projects what percentage of the overall cost should be allocated to Environmental and Social Impact issues and who should pay those costs?