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Sustainable water management in Norway for a hundred years: - the industrial area Odda - Tyssedal as a case study.

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Abstract:

With 4000 watercourses and 250 000 lakes Norway is a water nation. Norway is also a hydropower nation. Hydropower development began towards the end of the 19th century. During the first decades of the 20th century power intensive industry turned Norway into an industrial nation. Industrial towns like Odda - Tyssedal, Ålvik, and Rjukan were established. Electricity transmission technology lagged behind production technology, which explains why industry had to be located close to a power source. In the years 1906-1917 foreign investments in hydropower led to concession laws which ensured reversion of ownership to the state after a period of time. These laws ensured that the government could control, and in the long run direct hydropower development in the country. Consequently by 2004 public power plants constituted 88 percent of the production capacity. In the years 1945 to 1980 hydropower production increased from 11, 0 TWh to 89,7 TWh. In the 1960s the pace of development was so fast that if any watercourse nature was to be preserved it had to be preserved quickly. The result was the first Protection Plan for River Systems in 1973. The plan included 95 watercourses. The Protection plan was expanded in 1980, 1986, 1994, and in 2005. Today 387 watercourses are protected against hydropower development.

Norwegian water resource management is seen as unique in an international context. In this paper we are going to study hydropower development and the conservation of watercourses, focusing on the industrial area Odda - Tyssedal in West Norway. We will briefly look at the significance of hydropower in light of industrial production until 1930. The cyanamide plant in Odda was part of the breakthrough of the international nitrogen fertiliser industry. In connection with work on the Protection Plan in the 1960s and 1970s the municipal council in Odda ended up being in favour of protecting a large watercourse. During deliberations in parliament a watercourse nearby was also proposed protected, contrary to NVE's (Norwegian Water Resources and Energy Directorate) recommendations. We are going to look at the various points of view presented at the time. When ownership of the power plants reverted to the state, the power company that produces electricity for the industry in Odda – Tyssedal, applied for permission to develop local watercourses to ensure the industry continued control over its own power supply. In 2005 the industry's need for electricity came into conflict with plans to establish Folgefonna National Park. We are going to have a look at the debate that then ensued.

In this paper we are going to show that hydropower development in the early 1900s provided the foundation for industry of great international significance. The necessity of curtailing hydropower development in order to preserve some of the characteristic watercourse nature in West Norway was

expressed in the 1973 Protection Plan for River Systems. In 2005 the needs of the industry were set aside in favour of conservation. We regard Odda – Tyssedal as documenting in miniature Norwegian water resource management over a hundred years, providing a unique opportunity for up-close study. It is this micro-level approach that is new and noteworthy about our study. The sources are newspaper articles, international literature about the nitrogen industry, reports and documents from company archives, as well as studies made in connection with the Protection Plan, and impact analyses.

Introduction:

With 4000 watercourses and 250 000 lakes Norway is a water nation. Norway is also a hydropower nation. Hydropower development began towards the end of the 19th century. During the first decades of the 20th century power intensive industry turned Norway into an industrial nation. Industrial towns like Odda – Tyssedal (Fig. 1), Ålvik, and Rjukan were established. Electricity transmission technology was lagging behind production technology, which explains why industry had to be located close to a power source. In the years 1906-1917 foreign investments in hydropower led to concession laws which ensured reversion of ownership to the state after a period of time. These laws ensured that the government could control, and in the long run direct hydropower development in the country. Consequently by 2004 public power plants constituted 88 percent of the production capacity.

In the years 1945-1980 hydropower production increased from 11, 0 TWh to 89, 7 TWh. A number of large and attractive watercourses were put to use. The environmental changes were especially great in instances where it had been permitted to transfer water from one watercourse to another. Environmental political reactions were present to an increasing extent throughout the entire development period. During the 1960s the pace of development was so fast that if any watercourse nature was to be preserved it had to be preserved quickly (Faugli, 2005). The result was the 1973 Protection Plan for River Systems, where 95 watercourse objects were permanently protected, and 51 watercourses were temporarily protected while more information was gathered. The Protection Plan was expanded in 1980, 1986, 1994, and in 2005. Today 387 watercourses are protected from hydropower development.

Industrial towns grew around the hydropower plants constructed in the early 20th century. These areas were strongly influenced by national water resource politics. Firstly as ownership of the hydropower plants reverts to the state, the industry in these areas is greatly concerned about its need for affordable electricity through own production. Secondly the watercourses where development is still an option are located in these areas. Because national water

resource politics has been such a strong influence on these towns, we can say that they document Norwegian watercourse management over a hundred years (Faugli & Bjørsvik, 2005).

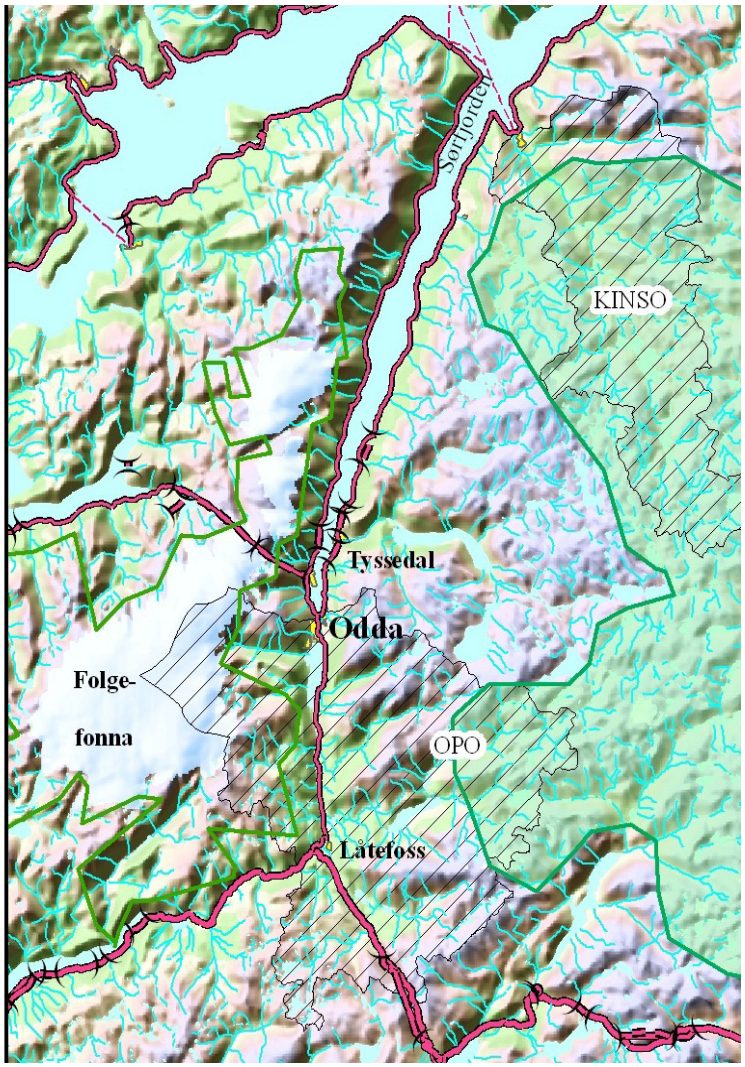

Fig. 1. Map of the area Odda-Tyssedal and surroundings with the national parks (Hardangervidda in the east and Folgefonna (with glaciers) in the west and the protected watercourses Kinso and Opo. The watercourse between them, the river Tysso, is regulated and today has and mean annual production of 2, 2 TWh..

Green line = border national park
Red line = road, ( ) = tunnel
Shaded area = catchment area of protected river
The length of Sørfjorden is 38 km.

From: NVE

Methods

In this paper we are going to study hydropower development and protection of watercourses using the industrial area Odda – Tyssedal in West Norway as the focal point. The study is qualitative and empirical and covers a hundred year period. It employs the methods of historical study. First we are going to look at the significance of the area's industry in an international context. The cyanamide plant was part of the breakthrough of the international nitrogen fertiliser industry. Secondly we are going to look at the growing influence of

environmental conservation. In connection with work on the Protection Plan for River Systems in the 1960s and 1970s Odda municipality changed its position from development to protection regarding one of the largest watercourses in the area. During deliberation in parliament another watercourse in the region was proposed protected, against NVE's (Norwegian Water Resources and Energy Directorate) recommendations. We are going to look at the different points of view presented, and offer some explanations as to why the conservation idea gained such momentum in the 1960s. Finally we are going to look at the current situation. As ownership of the power plants began to revert to the state, the power producers applied for permission to increase their own production of power. In 2005 the industry's need for power came into conflict with plans to establish Folgefonna National Park. We are going to look at some of the arguments presented. The sources are newspaper articles, reports and documents from company archives, international literature about the nitrogen industry, and various government reports. What is new about our approach is to have a study at this micro-level.

Results

Over a few years in the early 1900s Tyssedal and Odda changed from agrarian communities to industrial communities (Fig. 2 and 3). The reason was that the area offered a lot of easily available hydropower resources. The cost of building and running hydropower facilities was cheaper in Norway than in many other countries.

In addition the hydropower potential was greater. This can be seen in Table 1, 0 which is based on contemporary calculations of the hydropower potential in some European countries in the early 1900s.

Table 1.0 Calculation from the early 1900s regarding developable hydropower in European countries

Country	Developable HP	Developed HP	Developed in percentage
Germany	1 452 600	489 900	17
France	5 524 000	1 190 807	22
Switzerland	1 500 000	380 000	25
Austria	5 125 000	450 000	9
Hungary	550 000	56 000	12
Italy	5 500 000	464 000	8,4
Norway	7 525 000	301 000	4
Sweden	6 750 000	200 000	3

Source: Teknisk Ukeblad 1909, p. 38.

Fig.2a. Odda changed over a few years in the early 1900s from agrarian to industrial community. Photo: From NVIM – archive.

Fig. 2b. Odda with the fjord Sørfjorden. Photo: Harald Hognerud, NVIM

Fig. 3a. Left: The outlet of river Tysso in the fjord Sørfjorden, Tyssedal before 1905. Photo: From NVIM – archive.
Right: The same area today with the river in a tunnel. Photo: Per Einar Faugli, NVE

Fig. 3b. The industrial area in Tyssedal (left) with the now protected hydropower plant Tysso I (right), which stopped producing 1990. (The new hydro power plant is built in the mountain). Photo: Per Einar Faugli

Fig 3c. Tysso I, the first stage of the plant at 1906, formed the basis of the industries at Odda and Tyssedal. Photo: Tyssefaldene A/S – from NVIM – archive.

In Tyssedal the water resources had few owners. This meant that it was easy for the establishing industry to work out a deal regarding hydropower development and supply of electric energy. Legislation ensuring ownership reversion to the state did not yet exist when work commenced in Tyssedal. With English capital and a licence for the production of the nitrogen based fertiliser cyanamide, one of the world's first cyanamide plants was built in Odda. In 1908 it was the largest in the world. The plant in Odda was built with an eye to the future. We see this in the size of production, the rapid expansion of the plant, descriptions in the newspapers, and in the effort put into research and development work (Bjørsvik, 2006). In English newspapers in 1913 we find headlines like: *Nitrogen from the Air. An Account of a Remarkable Enterprise – The Nitrogen Products and Carbide Company, Limited: The largest and most important undertaking of its kind in the world* (Reprints of Newspaper Articles on the Carbide and Cyanamide Works at Odda, 1913). Chemical engineer Erling B. Johnson patented the Odda process, which was a revolutionary approach to producing full fertiliser (Sogner, 2005).

Surveys from the 1950s indicated the possibility of constructing three power plants with a production capacity of 950 GWh in the Opo watercourse (catchment area 483 km^2). In addition the Kinso watercourse (catchement area 280 km^2) was indicated to have a hydropower potential of 1100 GWh (Arbeidsdirektoratet, 1956). During work on the Protection Plan in the 1960s and 1970s, Odda municipality reversed a resolution to develop the Opo watercourse, and opted instead for conservation. NVE proposed the watercourse for conservation. If Opo became protected hydropower development in the nearby Kinso watercourse ought to be permitted (Ministry of Industry, 1972) Initially NVE saw the two watercourses as having equal merits for conservation, but the watercourses were given different recommendation because the municipal council in Odda was in favour of conservation, while the municipal council in Ullensvang wanted to develop hydropower in Kinso (Ministry of Industry,1972). Many spoke out against hydropower development in Kinso. It was one of the few watercourses in West Norway that was relatively intact from the nival zone to the sea. It was one of the larger watercourses from the Hardangervidda mountain plateau that was relatively untouched by hydropower development. The watercourse was intended as part of a major hydropower project. If these plans became reality a characteristic type of nature, the typical West Norwegian valley with much precipitation and fertile vegetation, would be lost forever. Protecting the Kinso watercourse would be a valuable addition to the planned Hardangervidda National Park. The watercourse

had great value as a reference watercourse in connection with research (Ministry of Industry, 1972). While the Opo watercourse ran through an industrial area at its lower end, Kinso ran through a natural landscape from the mountains to the fjord. Many of the landowners were in favour of protection. The Committee for Watercourse Development did not see any reason why the two watercourses should be pitted against each other. Claims of equal conservation value were made, but insufficiently substantiated (Ministry of Industry, 1972). The County Governor and County Council in Hordaland found that no new information had been presented to alter their acceptance of NVE's recommendations. According to the conservation proposal protection of the Opo watercourse might lead to a power deficit by 1982, which was, according to the county's Electrical Power and Industry Committee, a strong argument against conservation. With a hydropower potential of 950 GWh the Opo watercourse was by far the largest watercourse in the Protection Plan Proposal for Hordaland. The committee felt that the conservation recommendation focused too much on the benefits of conservation, and that it did not sufficiently take into account the interests of the industry, or adequately map what the consequences of protection would be for the district or region. The Ministry of Industry decided to recommend protection of Opo and Kinso for a period of 10 years in order to complete further study (Ministry of Industry, 1972).

During the period of time leading up to the first Protection Plan for River Systems several changes took place: first of all the municipal council in Odda reconsidered and decided against developing the Opo watercourse. Secondly the Ministry's final recommendation went against the opinion of NVE and the majority of the municipal council in Ullensvang, by proposing temporary protection of the Kinso watercourse. They also proposed to temporarily protect the Opo watercourse (Fig. 4a). However, parliament resolved to protect permanently both watercourses because they constitute a large area free from hydropower development (Stortinget, 1973)

NVE's proposal for a Protection Plan received little criticism when on hearing. This can be explained by the process which led up to the plan. In principle work on the plan had been underway since 1960 until the proposal was put forward in 1971. The conclusions in the reports were clear: if hydropower development was not curtailed all watercourses would be developed by 1980. Electricity consumption had doubled every decade since World War II. Even though only 50 percent of the production potential was exploited, far more than half of the developable watercourses had been put to use, because the areas that were most

accessible and cheapest to develop had been given priority. Transferring water from one watercourse to another had great environmental impact. There was a realisation that the benefits of hydropower expansion had to be weighed against the interests of the public. It became accepted that when developing rational management strategies, ecological knowledge had to be a factor. The idea of conservation also gained acceptance as technology for developing alternative energy sources, like thermal power stations and nuclear power stations, emerged. Also there was a realisation that whether some watercourses became protected or not hydropower development was nearing the end. In the long run Norway could not cover an increase in electricity consumption through further hydropower development. Protests against hydropower projects had been a factor throughout the century. Pressure from various groups and organizations was building (Næss, 1977). In 1970 the proposal to develop one of the highest waterfalls in the country led to fierce protests. In Odda – Tyssedal the waterfalls Ringedalsfossen (Fig. 4b) and Tyssestrengene, which had a drop of 300 metres, were developed for hydropower production in the 1960s.

Fig. 4a: The famous waterfall Låtefossen in the protected watercourse Opo. ▲
Photo: Per Einar Faugli, NVE

4b: The waterfall Ringedalsfossen – regulated. ►
Photo: Harald Hognerud, NVIM).

In 2005 the power company AS Tyssefaldene supplied the industry with electricity from three power stations. Ownership of one of the power stations reverts to the state in 2007, but the power company has a lease until 2031. The power company is leasing the other two power stations until 2011. To the power intensive industry electricity is as important as any raw material: control over access and price is important. Having control over the production of power makes the industry less vulnerable to changes in the electricity market. In 1998 AS Tyssefaldene began work on a project to develop two parallel watercourses in Odda municipality. The same year work began to establish Folgefonna National Park. In 2003 a proposal for protection and an impact analysis for the national park were sent on hearing. The boarders of the national park included the upper sections of the water courses planned for development. The reasons for creating the Folgefonna National Park was among else to preserve a unique natural and cultural landscape, secure valuable watercourses, take care of areas that are untouched by technology, as well as preserving cultural heritage. In this context the protection of the watercourses was an important contribution to establishing a large national park. In addition the watercourses had not been altered by technology. On and around Folgefonna wilderness areas have been greatly reduced due to hydropower development. Folgefonna is an area with much precipitation. By 2005 more than half of the area's hydropower potential had been developed, and further plans were underway. The power company's mapping of power resources showed that of a total of 4165 GWh, 700-800 GWh had not yet been exploited. 200-300 of this potential was located within the intended boarders of the national park. Was it possible for hydropower development and nature conservation to co-exist? The Hordaland County Governor believed that the plans for development could not be incorporated into the conservation plans. NVE advised that hydropower development be permitted. Odda municipality also welcomed the plans for hydropower development. The power companies and NVE believed that the financial consequences of protection, as well as the benefits to society had not been sufficiently explored in the conservation proposal. NVE believed that the proposal was not in accordance with parliament's view of the relationship between a national park and projects in the Master Plan for Water Resources, category I. In a national context projects that may be considered for concession are placed in the Master Plan, category I. The watercourses in question had been placed in this category. The goal of the Master Plan is to ensure that watercourses that can be developed cheaply and with little environmental impact, are to be developed first. The plan was passed in 1986, and revised in 1993. Regarding the relationship between the Master Plan for Water Resources and national parks, parliament has stated that:

> "As regards conservation proposals relating to hydropower projects in Category I the Ministry will find solutions so that establishing protected areas will not hinder concession deliberations. From the knowledge available today there seems to be no conflict between category I projects and the national plan for national parks" (Ministry of Environment 1992).

The proposed national park area was 600 km^2. The hydropower development area would be 4-5 km^2. NVE believed that the quality of the remaining area would not be significantly diminished to such an extent that it would impact the decision to establish a national park for the entire Folgefonna area. NVE also held that it was unfortunate to first include an approved Master Plan project in a proposal for a national park, and then claim that if the watercourses were not included the establishment of this section of the national park was in danger. The watercourses could be developed because they were not untouched by technology: they had been developed for water supply, and flood and erosion prevention measures were in place. Damage to the ecological processes in the watercourse would be limited. The claim that the mouth of the rivers provided good fishing opportunities was not well documented. If the hydropower project was carried out it would increase the industry's own supply of electricity. Other advantages were that water supply to the factory would improve, and that the danger of flood would be reduced. Measures could be taken to make the impact of the development less noticeable to those who make use of the area.

The Directorate for Nature Management (DN) and the County Governor believed current knowledge superseded the Master Plan. The Ministry of the Environment supported the County Governor and DN's assessment. The watercourses had been placed in category I of the Master Plan in the 1980s. It was held that the data which led to this decision was inadequate in relation to nature conservation and the topic fish. On the 29th of April 2005 the Ministry of the Environment decided to establish Folgefonna National Park, permanently protecting the two watercourses in question.

Questions arise regarding what consequences this decision will have for the industry's need for an own supply of electricity, as well as consequences for the industrial community in general. In the case of AS Tyssefaldene work is carried out to establish miniature power stations. The 1973 Protection Plan for River Systems was until 2005 expanded to include 387

watercourses, which have a hydropower potential of 44, 9 TWh. In total 120, 9 TWh is developed (Fig.5).

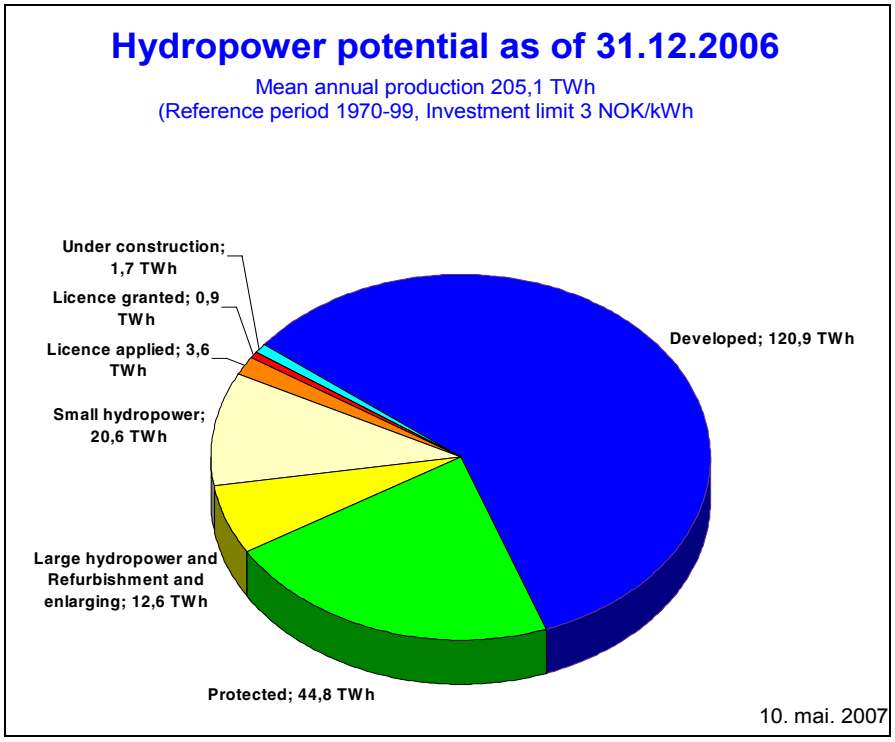

Fig. 5. Hydropower potential in Norway 31.12.2006. From: NVE.

In 2002 the government allowed the construction of smaller hydropower plants in protected watercourses also. The resolution to allow small power plants was based on the desire to improve conditions for businesses in rural areas, as well as a need to expand domestic power production in order to improve the power balance.(Ministry of Petroleum and Energy, 2003) In protected watercourses these plants have an upper limit of 1 MW.

Conclusion

Since the beginning of the 20th century hydropower development has been a central factor in the modernisation of Norway. Industrial towns based on hydropower grew rapidly, and the industry's production had great international significance. Work on the Protection Plan for River Systems in the 1960s must be seen in context with the pace of hydropower development, but other factors are the way hydropower projects were planned, the lack of assessment beyond the immediate financial benefits, and pressure from various groups in society. In order to prevent that all watercourses were developed by 1980 steps had to be taken. There were few objections to NVE's Protection Plan, which had been in the works for

over 10 years. Instead there was a will to protect more watercourses than were covered in the proposal. It was emphasized that the value of watercourses proposed developed was insufficiently documented. The conservation of watercourses must also be seen in context with the possibilities for alternative energy sources, and the position that the power intensive industry was to have in the future. In 2005 the industry in Odda's hydropower project was rejected: establishing Folgefonna National Park was regarded as more important. The possibility of constructing smaller power plants in protected watercourses does, however, show that the country still bases its need for electricity on hydropower. Whether this will impact the value and status of protected watercourses is a topic of debate. The local energy company in Odda in the rolling plan of 2005 includes 7 projects in the protected Opo watercourse with a simulated yearly production of 60 GWh (Vestnorsk Enøk & Odda Energi 2005).

Today Odda and Tyssedal is located between the two large national parks Hardangervidda (established 1981) and Folgefonna. In this area we find both developed watercourses and protected watercourses. The way the nature and watercourses surrounding the industrial community has been exploited is an important document of Norwegian water resource management over a hundred years.

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