

Schmitz, Dominik

**Research Report**

## Developing a methodology for assessing the sustainable development impact of small scale CDM hydropower projects

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# REPORT

# **Developing a methodology for assessing the Sustainable Development impact of Small Scale CDM hydropower projects**

**Dominik Schmitz**

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# **Developing a methodology for assessing the Sustainable Development impact of Small Scale CDM hydropower projects**

**Dominik Schmitz**

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## **Executive Summary**

The Clean Development Mechanism (CDM), one of the flexible mechanisms of the Kyoto Protocol, started with the setup of the Executive Board in November 2001 and registered the first CDM project in November 2004. The CDM focuses on two objectives: reduction of Greenhouse gases (GHG) and contributing to the Sustainable Development (SD) of the host country. While the CDM framework assures the project contribution concerning GHG reduction, the promotion of SD is not so obvious and heavily discussed. Sustainable Development in the CDM means that projects have to be implemented in a sustainable manner as to avoid negative environmental, social and economic impacts. Without proper assurance that projects contribute to Sustainable Development in host countries, the second goal of the CDM might not be reached and the mechanism might degenerate to a simple market tool for cheap emission reductions.

Generally, the host country's Designated National Authority (DNA) is responsible for assessing the projects' sustainability impact. Only in some countries the assessment is carried out with specific country based sustainability criteria for the projects. These sustainability criteria focus on the special development path of the country. However DNA assessments are criticized by several authors (Sutter, 2003) and NGO's like WWF (2003: 3), Down to Earth (2005) for being too weak and thereby leading to an acceptance of projects that will not promote SD in the host country. In fact, rarely projects have been rejected by the DNAs'. This had been investigated by the author and his colleague at the Carbon Expo 2005 in Cologne (see also Burian 2006, 49).

In the CDM, hydropower projects represent an important group, with 39 registered projects from 222 in total (20 June 2006). Hydropower projects have mostly a bigger impact on social, environmental and economic issues than other CDM projects e.g. end of pipe projects.

In reaction to this challenge, different organisations (BMU) and official documents (Linking Directive) have expressed their motivation to refer to the World Commission on Dams guidelines for CDM Hydropower stations bigger than 20 MW (DIW/HWWA

2004). Official recommendations or criteria for Small Scale hydropower facilities, however, are not defined.

The thesis will show a lack concerning sustainability guidelines from international and national organisations noted for hydropower development and the CDM guidelines. Thereby it will be pointed out, that the existing CDM regulations aiming to assure the Sustainable Development, namely the Host Country Approval, the local stakeholder period and the global stakeholder period do not perform well. The first part of the thesis will end in the statement that the existing CDM rules are not suitable to guarantee the goal of Sustainable Development as far as hydropower is concerned.

In the second part of the thesis a methodology for SD assessment of CDM small scale hydropower facilities is developed and presented. Defining such a methodology is a typical problem of sustainability. Economic, ecologic and social interests have to be carefully considered and in this thesis, are supported by reference guidelines. A second challenge is, that the methodology needs to be implemented in the existing CDM framework as well as the existing voluntary CDM Sustainable Development assessments. The key elements of the methodology are specific sustainability criteria for small scale hydropower facilities. Those criteria are specified by indicators and measures, so that they can be used by DNA's, project developers and NGO's.

During a field visit in India, the CDM host country with the largest number of projects, the author had the chance to visit three hydropower facilities. There the methodology was tested and showed that the projects did fail in several important aspects of SD. In addition the situation in India concerning the Host Country Approval was investigated.

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## Abbreviations and Glossary

-Annex I	Member countries of the OECD in 1992, plus countries in transition states. Those countries have commitments to reduce Greenhouse gas emissions.
-Non Annex II	Countries who signed the Climate Convention but have no commitments
-BMU	German ministry for the environment
-BUWAL	Swiss Department for environment, forest and landscape
-CDM	Clean development mechanism
-CER	Certified emission reduction
-CO <sub>2</sub> e	Carbon dioxide and equivalences measured in carbon dioxide
-CoP	Conference of the parties
-DNA	Designated National Authority
-DOE	Designated Operational Entity. An entity designated by the COP/MOP, based on the recommendation by the EB, as qualified to validate proposed CDM project activities as well as verify and certify reductions in anthropogenic emissions by sources of GHG. A DOE shall perform validation or verification and certification on the same CDM project activity.
-EB	Executive Board of the UNFCCC
-EC	European Commission
-EBRD	European Bank for reconstruction and development
-EA	Environmental assessment, the whole procedure of the assessment, with screening, scoping...
-EIA	Environmental impact assessment, the assessment of the physical and biological impacts at project site
-ERU	Emission reduction units
-EMP	Environmental management plan
-End of pipe	Projects reducing GHG by direct destruction of the gases e.g. at the end of the pipe, like HFC gases.
-ESHA	European Small Hydropower Association
-EU	European Union

-GHG	Greenhouse gases
-GS	Gold Standard, a label for premium CER. Projects with the GS have been approved by certifying companies that they comply with predefined sustainability criteria.
-GS-PDD	Gold Standard Project Design Document
-GTZ	German Technical Cooperation, a german ODA organisation
-GWh	Giga Watt hours
-ha	Hectare
-HFC	Hydro fluor Carbon
-IEA	International Energy Agency, the IEA is an autonomous body within the framework of the OECD.
-IFC	International Finance Corporation
-IHA	International Hydropower Association, a non-governmental professional association under the auspices of UNESCO
-IRN	International River Network, international NGO working on ecologic and social development of rivers
-ITDG	Intergovernmental Technology Development Group
-IUCN	International Union for Conservation of the Nature
-JI	Joint Implementation
-KfW	Bank for Reconstruction and Development Germany
- Linking Directive	The Linking Directive rules the applicability of CDM certificates (called CER) in the European trading scheme
-LOA	Letter of approval
-MCDM	Multi criteria decision making
-MW	Mega watt
-MZB	Macro zoo benthos
-NAP	National allocation plan
-NGO	Non governmental organization
-ODA	Official development assistance
-OECD	Organization for Economic Cooperation and Development
-PDD	Project Design Document
-Residual flow	Water that is not diverted for creating energy, but remains in the main riverbed.

-ROR	Run of the River hydropower project
-SEA	Strategic Environmental Assessment, a more consultative, iterative and open ended process
-SD	Sustainable Development
-SSC	Small Scale project
-SSN	South South North, a non-profit NGO which facilitates the development of the CDM, engaged in capacity building
-UN	United Nations
-UNDP	United Nations development Program
-UNFCCC	United Nations Framework on combating climate change
-WFD	European Water Framework Directive
-WB	Worldbank
-WCD	World Commission on Dams, founded in 1997 by World Bank and World Conservation Union

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### **A note on the conception**

This thesis is part of a co-research project being planned, organized and conducted in cooperation with Martin Burian. As this thesis and Burian' master thesis: "The Clean Development Mechanism, Sustainable Development and its Assessment" focus at related topics and at a more or less similar time, both works refer to each other. Some topics are divided into the two thesis, consequently it can be useful to read some of the chapter simultaneously. Martin, thanks also to you for the good time and brain racking discussions we had. The flights to India had been made CO<sub>2</sub> neutral.

*Thus this issue is of „such a manner that it needs thorough considerations .... detailed and sufficient investigations of the doubtful points so that in the following a responsible proposal can be performed by the delegated Collegio”.*

J.W. von Goethe<sup>1</sup>, 5th March 1781

## 1. Introduction

Climate change is an intrinsic factor of earth history. Since the human industrialization the human specie has influenced the climate through the emission of Greenhouse gases such as CO<sub>2</sub> and methane. The anthropogenic share of global warming is estimated to have increased the mean annual temperature from 1900 until 2000 by 0.5°-0.7° Celsius (IPCC, 2001). This anthropogenic global warming is confirmed by almost all countries and scientists of the world. Besides predictable effects such as rising sea levels, the rising of the mean annual temperature includes non- predictable effects due to non-linear feed back<sup>2</sup>. The “environmental summit” of Rio in 1992 decided to fight against anthropogenic global warming and in the consequence the Kyoto Protocol was launched in 1997 aiming to reduce the anthropogenic share of global warming by country based greenhouse gas caps.

Development and increasing electrification still leads to higher worldwide energy demand and consequently to greater CO<sub>2</sub> emissions. The International Energy Association (IEA) predicts an increase of energy by two-thirds in the next 30 years. Fossil fuels will continue to dominate the energy mix. About two-thirds of the growth in energy demand will arise in developing countries<sup>3</sup>.

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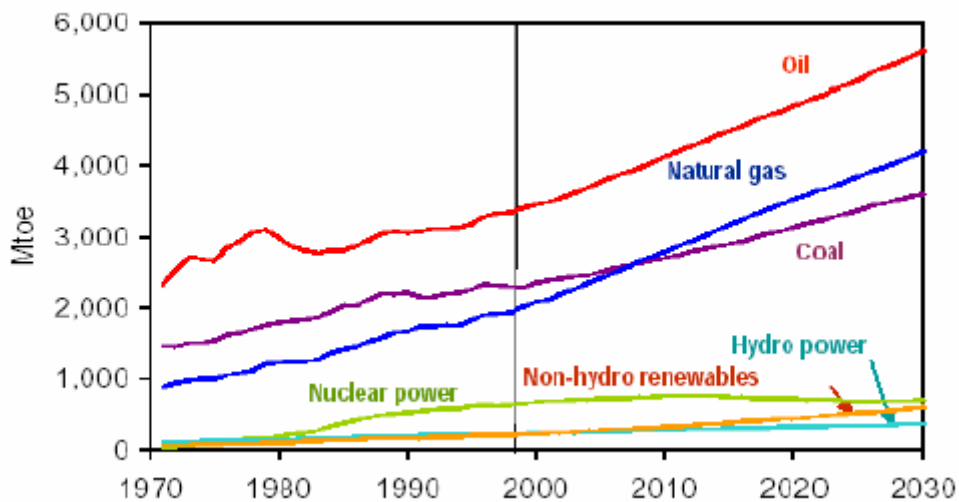
<sup>1</sup> As responsible (Geheimer Rat) for hydraulic questions in Weimar (own translation)

<sup>2</sup> Releases of carbon and methane currently sequestered in the Permafrost (Ford 2005). Methane emissions resulting from the thaw of the Siberian Permafrost can lead to a rise of global warming by 25% (Daily Telegraph, The Guardian 11.8.2005).

<sup>3</sup> Particularly in the fast growing, new industrialized countries like India, Brazil, China (Umbach 2004)



**Figure 1: Trends in the world primary energy demand (IEA, World Energy Outlook)**



Financing the required expansion of new infrastructure is a huge challenge, depending largely on the framework which is created by governments (IHA, 2003). Governments are well advised when they direct their energy policy towards renewable energy sources thus the conventional energy resources like coal, gas, and oil will not be financially viable in the next century. Projections see the end of viable oil exploitation within 41 years and gas within 60 years (Umbach 2004).

A switch towards renewable energy will not be an easy task since most renewable energy sources are unreliable suppliers (wind, solar). In order to have a continuous supply of these sources, storing would be necessary thereby causing remarkable losses of energy. Hydropower, on the other hand, is a reliable renewable energy due to the possibility of storing the water. For this reason it will play an important role in future energy supply. Further advantages of hydropower include:

1. High efficiency with over 80% (IHA, 2003)
2. CO<sub>2</sub> neutral
3. Multi-purpose use, such as for irrigation, shipping, flood protection, recreation...
4. Decentralised energy service

Hydropower<sup>4</sup> facilities are considered as a „green“ power generating methodology. Unfortunately, this is not the end of all energy supply problems thus also hydro facilities can have considerable negative effects on the balance of ecology (loss of biodiversity), social structure (loss of land) and economy (depths). There are several examples of hydropower facilities that have harmed rather than served people and nature. Reacting to those problems Official Development Agencies and Financing Institutes initiated guidelines for sustainable hydropower, with the most famous being the report of the World Commission on Dams in the year 2000. Small hydropower facilities have, however, generally no guidelines concerning their potential negative effects.

The Clean Development Mechanism (CDM), one of the flexible mechanisms of the Kyoto Protocol, was set up with the focus on two goals: reducing Greenhouse gases in a cost effective way and contributing to Sustainable Development of Non-Annex I countries. (UNFCCC, 1997 Art. 12): “The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving Sustainable Development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments (...).”

The CDM started with the setup of the EB in November 2001 and registered the first CDM project in November 2004. In the CDM, hydropower represents an important group of projects, with 36 registered projects from 189 projects in total (20 May 2006). Within the CDM hydropower projects have mostly a bigger impact on social, environmental and economic issues than other CDM projects e.g. end of pipe, solar, or wind projects. In reaction to this challenge, different organisations (BMU) and official documents (Linking Directive<sup>5</sup>) have expressed their motivation to refer to the WCD guidelines for CDM hydropower stations bigger than 20 MW (DIW/HWWA 2004). Official recommendations or criteria for Small Scale hydropower facilities, however, are not defined.

---

<sup>4</sup> Especially a Small Scale run of the river hydropower facility

<sup>5</sup> The Linking Directive rules the applicability of CDM certificates (called CER) in the European trading scheme.

## 1.1 Defining the problem/scientific demands

While CDM guidelines assure the positive impact of the projects concerning combating Greenhouse gas emissions, the impact of the projects towards Sustainable Development is not so obvious and heavily discussed. Without proper assurance that projects contribute to Sustainable Development in host countries, this second goal might fail and the CDM might degenerate to a simple market mechanism for cheap emission reductions.

For all types of projects the host country is responsible for assessing the project impact on Sustainable Development (SD). In host countries the national agency, or Designated National Authority, has to define specific sustainability criteria for the projects. This SD check is criticised by several authors like Sutter and NGO's e.g. WWF or "Down to Earth"<sup>6</sup> for being too weak, thereby leading to an acceptance of projects that will not promote SD in the host country.

This thesis aims to contribute to the creation of a sustainable CDM, suggesting a methodology for assessing hydropower facilities. Finding criteria for SD in the context of the CDM is a typical problem of sustainability. Economic, ecologic and social interests have to be carefully considered e.g. looking at the consequences of hydropower projects it is necessary to compare them with the positive and negative impacts of other power generating options like coal, gas, nuclear power as well as other CDM project possibilities like renewables or end of pipe projects. Too high sustainability requirements for hydropower facilities would lead investors- and governments to withdraw and spend the money on other energy projects or other CDM projects. If, within the CDM sustainability criteria would be implemented only in hydro projects, the money would be spent rather on e.g. end of pipe projects. This must not be the result of sustainability requirements for hydropower, because end of pipe projects have less potential for a positive impact on SD (see therefore Burian, 2005, chapter 5.1).

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<sup>6</sup> "Down to Earth" is an Indian NGO assessing CDM projects, <http://www.downtoearth.org.in/>

## 1.2 Methodology and research questions

This Masters thesis was initially planned together with my friend and colleague Martin Burian. Bearing in mind the broad realm of sustainable CDM hydropower, we decided to split the topic. While Burian addressed the theoretical part with an economic analysis of sustainability lacks, this thesis deals with practical sustainability issues.

Designing a criteria catalogue to guarantee that hydropower projects within the CDM do finally contribute to Sustainable Development was performed in the following way. The author analysed reference material on hydropower planning, decision making and construction guidelines. This “baseline” consists of environmental regulations and safeguard policies of several organisations active in the hydropower sector, like the World Bank, IHA, the European Union. Additional information and concepts were gathered from the two worldwide unique „green“ hydropower certifications, the Swiss EAWAG and America Low Impact hydro<sup>7</sup> certification. First-hand knowledge of ODA hydropower facilities and lessons about their impact towards Sustainable Development have also been taken into account.

In the second step existing rules and methodologies which should assure Sustainable Development in the CDM are investigated. Problems which arise from existing methodologies are discussed and the need for detailed criteria is clarified. In designing a criteria catalogue for „green“ hydro it is necessary to investigate both the legal and financial framework. Therefore, the legislation, the economic possibilities and the buyer’s perspective in the CDM will be discussed. Criteria for sustainable Small Scale CDM projects were selected according to their ecologic, social and economic relevance, their cost-benefit ratio and practicability. Important modifications for the catalogue were made during a field study of three CDM hydropower facilities in India.

During research it was necessary to specify certain types of Small Scale hydropower facilities. Otherwise the criteria catalogue would have been too extensive. Rare types of Small Scale plants like dam and peaking hour facilities have not been addressed.

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<sup>7</sup> However, they focus especially on large hydropower facilities.

Rather, the criteria catalogue was designed for Diversion type and River-power plants since these are the most common in the CDM (over 90%). Although these plants are considered the greenest hydro projects, the author shows that even for these types of projects concerns about sustainability exist as following Hoj/Wörgötter (2002) it is not clear why small hydropower stations should be less detrimental to the environment than large ones. This means that all projects, even the “greenest,” require sustainability criteria. Criteria Catalogues for other projects supported by the CDM, as well as for large hydro and facilities with dams, must follow.

**Research questions:**

1. Are CDM hydropower sustainability requirements comparable to international hydropower sustainability guidelines?
2. What are the main obstacles for sustainable CDM Projects?
3. Which are the most important criteria in assuring that hydropower is contributing to Sustainable Development?
4. Which binding criteria related to sustainability can be implemented so that CDM Small Scale hydropower facilities still attract potential investors?

## 2. Definitions

### Small Scale hydropower

Small hydropower is usually divided into Pico, Micro, Mini and Small hydro. The exact definition of the size varies within different countries however the commonly used definition for small hydro is an installed capacity of not more than 10 MW (OEZA 2004: 22). This means that the CDM with a definition of 15MW for small scale is in the upper range.

**Table 1: Definitions of small hydropower<sup>8</sup>**

Country	Micro (KW)	Mini (KW)	Small (MW)
CDM			<15
Various in EU	< 100	< 1000	< 10
France	<5000	-	8
United States	< 100	100 - 1000	<30
India	< 100	101 - 1000	<15
China	-	< 500	0.5 - 25

Small hydraulic power plants only have limited storage capacity. When the river dries up and the flow falls below some predetermined minimum amount, generation ceases<sup>9</sup>. Therefore, the water can not be used for peak hour production (ESHA, 2004).

### Run of the River

Run of the River plants do not dam or store water. The facilities depend on the discharge curve of the river and the turbine generates electricity as water is available (EC, 1998 [a]). Small Scale Run of the River facilities have different designs. Diversion type facilities are the most common in the CDM. These facilities take water from the river, leaving only the prescribed minimal water flow in the rest water bed. The water is diverted by a channel which leads with a low slope to the forebay. From

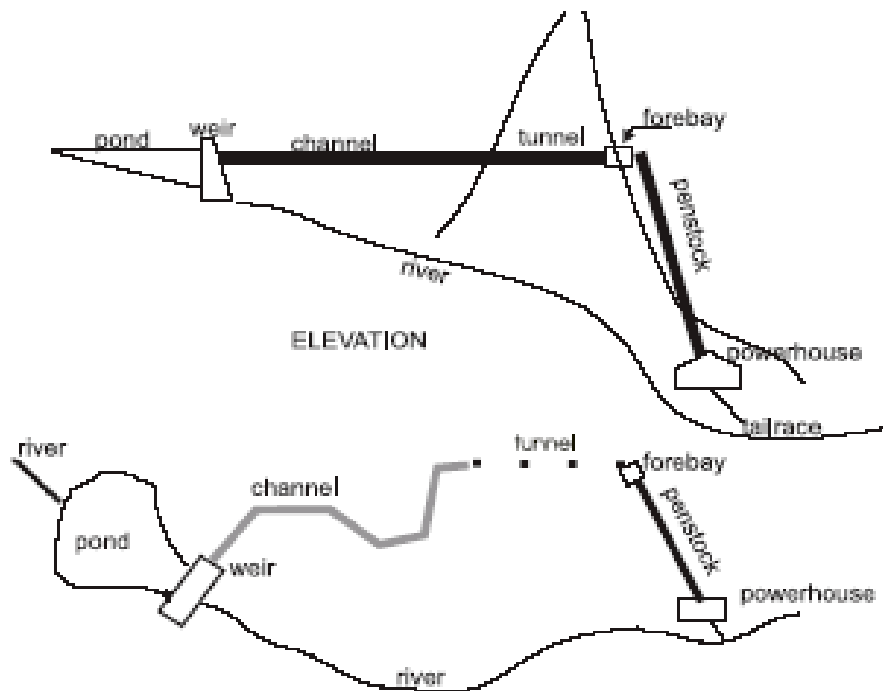
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<sup>8</sup> From: EU Laymans Guidebook (1998); Moreire, J.R. & Poole, A.D. (1993) in: Johansson T.B. et al, (1993); Report No. 17/1991, Norwegian Water Resources and Energy Administrations (NVE).

<sup>9</sup> Due to the minimum technical flow of the turbine equipping the plant

this forebay tank the water falls down the penstock creating fall energy used in the powerhouse.

**Figure 2: Scheme of a diversion hydropower station<sup>10</sup>**



The second type of run of the river facilities are river power plants. Those are built directly in the river, the water is not diverted. River power plants usually have a low head.

### **Environmental Assessment**

Environmental Assessment is the umbrella term for assessing potential impacts on the environment. Strategic Environmental Assessments (SEA) refer to issues covering a larger geographical scale and focus on strategic impacts, while environmental impact assessments (EIA) have a greater focus on a particular project at a particular location (EC 1998 [a] part two: 20). Several tools are possible for this assessment with the most common being Environmental Impact Assessment (EIA) or Environmental Management-Plans.

---

<sup>10</sup> From Layman's Guidebook 2004: 17

### **3. Small hydropower and Sustainable Development**

Worldwide hydropower contributes 19% of the total primary energy production (IHA 2003). 95% of this energy is produced by facilities larger than 10 MW, leaving 5% for Small Scale hydropower facilities (Short/Keegan 2000). The hydro potential is not the same in each CDM country; however, the use of hydropower is possible in almost all countries. Hydropower is economic in regions with high annual precipitation and cool climates which reduce evaporative losses and make it possible to store water naturally in the form of snow. Such conditions are particularly common in the northern and southern latitudes as well as in high mountain ridges like the Himalayas and the Andes. Here hydroelectricity is an attractive and sufficient stand-alone option for water use (IEA 2002) while in other parts of the world, particularly where a shortage of water exists, it is often feasible to combine hydroelectricity with storage of water for e.g. irrigation. The economics of small and large facilities vary greatly. Large plants are often financed by several groups of international investors while small projects have mostly private project developers.

Hydropower and Sustainable Development is a broadly discussed topic. The following chapter will summarize potential negative and positive impacts of hydropower facilities describing linkages between hydropower and Sustainable Development. There are two dominant views when it comes to hydropower and its role for Sustainable Development. International River Network (IRN 2004) on the one hand states that, „the technology can only play a role in sustainable energy development if its planning and management are subject to strict guidelines and criteria, alternatives are fully considered and projects are implemented through transparent and accountable processes“.

This perspective has lead several financing organisations to develop guidelines and criteria for hydro facilities, with most famous being the World Commission on Dams report in 1998. European Small-Hydropower Association (2004), on the other hand, describes very hauntingly the general view of most project developers concerning impacts on the environment. „regarding the fact, that the production of hydroelectricity does not emit polluting substances, electricity from a hydropower plant could be



considered as clean. What can be added is that a special care has to be taken to limit the local environmental impacts of the turbine setting and operations on the ecosystem where the turbine acts“.

This view can lead to several problems in the social and environmental project environment. In talking about sustainable hydropower, it is essential to look at the specific project framework which exists in the host countries. While industrialized countries and International Financing Organizations ensure social and environmental standards in most developing countries and in the CDM framework those standards are missing. This means that CDM projects mostly lack sustainability guidelines. The following chapter will put a light on that situation.

### **3.1 Impacts of Small Scale hydropower constructions**

Problems with hydropower facilities can be traced back to their first installations. It is not easy to generalize negative impacts since facilities differ very much depending on different regional environmental, social and economic conditions. Furthermore the type and layout of the facility as well as the type of the water body makes it difficult to generalize impacts of hydropower on Sustainable Development. A precise assessment of a specific project in a specific social context can be determined only on a case-by-case basis.

However, one can predict potential sustainability problems of hydropower facilities and criteria important to focus on. Lists of positive and negative impacts of hydro facilities on ecology, society and economy can be found in numerous documents and will be described in chapter 3.1.1 and 3.1.2. Experiences of environmental impacts have mostly been gained in developed countries. Consequently research is needed assessing sustainability impacts in developing countries.

#### **3.1.1 Negative ecologic, social and economic impacts**

In discussing the potential positive and negative sustainability impacts listed below one should bear in mind that not every negative impact observed occurs automatically in every single project.

**Table 2: Potential negative ecologic, social and economic impacts**

<b>Water Quality</b>	Reduced oxygenation, stratification potential, pollutant inflow, propensity for disease proliferation, nutrient capture, results in eutrophication (Schmutz, 2005), (IHA, 2003).
<b>Water Quantity</b>	The rest water quantity in the stream which is not diverted for power generation is often not enough for a living ecosystem due to flow alteration, loss of velocity and loss of productive water course (Jungwirth 1995).
<b>Bedload deposition</b>	Effects of bedload deposition or erosion are a substantial alteration to the original channel structure and riparian area (Bratrich/Truffer 2001), (Jungwirth et al. 2003).
<b>Ecology</b>	Hydrology changes have an impact of “in stream” and “stream side” habitats like decrease of groundwater level, side rivers and old water bodies (IHA, 2003). Disturbance during construction modifies existing terrestrial and aquatic habitats (IHA, 2003). Loss of habitat, loss of dimension physical damages on fish and benthos fauna due to turbines, grids and sand trap cleaning (Schmutz 2005).
<b>Indirect impacts</b>	Change of hydrology can lead to dry wells or desertification of riparian zone and land. Methane emission may occur.
<b>Cultural sites</b>	Impact on cultural landscapes and human heritage (The GS 2003: 40).
<b>Lifestyles</b>	Substances, materials or diseases (malaria) which could be harmful to human health (The GS, 2003 :40 <sup>11</sup> ).
<b>Gender</b>	Only the male might benefit from the construction.
<b>Local economy</b>	Possible water quality and fishing losses or water withdrawal is affecting downstream riverside population (The GS, 2003: 40)

**3.1.2 Positive ecologic, social and economic impacts**

We have seen in this chapter that most negative effects on sustainability relate to ecology, while potential positive effects are generally social/economic. For a more detailed discussion on the positive sustainability goals and hydropower facilities please refer to chapter 3.

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<sup>11</sup> From CEC 1993, Environmental Manual

**Table 3: Potential positive impacts resulting from hydropower facilities**

<b>Ecologic impacts</b>	Water turbines increase oxygenation of the river (ESHA, 2004). When EIA are performed they enhance knowledge and can improve the management of valued species (IHA, 2003).
<b>Creation of income</b>	Hydropower facilities include large investments and often operate with a high contribution from local manpower and resources (IHA, 2003).
<b>Poverty alleviation</b>	Access to electricity can promote new economic activity, empower women by reducing domestic and repetitive chores, improve health and education services (IHA, 2003).
<b>Regional economic impacts</b>	Hydropower plants can run decentralised and assure energy needs of isolated villages (ESHA, 2004). This can instigate and foster regional development (IHA, 2003).
<b>Nation-wide economic impacts</b>	Hydro can offer energy independence, as it develops national resources and thus promotes self-sufficiency by avoiding national trade deficits incurred from buying foreign energy resources <sup>12</sup> and technical know-how (IHA, 2003) (Chopra 2004, ESHA, 2004).
<b>Compensation measures</b>	Affected communities can be provided with improved living conditions by ensuring equitable distribution of benefits, revenue sharing, training programs and educational outreach (IHA, 2003).

### 3.1.3 Greenhouse gases

The first goal of the Kyoto Protocol aims to reduce the amount of anthropogenic GHG. Project developers have to define the amount of GHG that is reduced by the project as well as the leakage<sup>13</sup> of the project. Up until October 2005, all hydropower projects claimed a leakage of zero in their PDD. A leakage of zero CO<sub>2</sub>e is however impossible because CO<sub>2</sub> emissions occur in any hydropower project, at least during construction. In facilities with dams remarkable amounts of methane emissions can occur (Rosenberg et al., 1995; Galy-Lacaux et al., 1999). Until now most studies concerning methane emission of hydropower have been performed in developed countries<sup>14</sup>. Run-

<sup>12</sup> The import dependence on crude and petroleum products rose up to 80% in 2004 and is likely to grow to more than 100% in the near future (Chopra, 2004: 4)

<sup>13</sup> Leakage: Measurable CO<sub>2</sub>e emissions which result from the project activity.

<sup>14</sup> Low temperature also increases the amount of dissolved oxygen and reduces the rate and extension of

of-river plants generally have lower emissions than reservoir power plants since run-of-river plants do not inundate areas and use less building material (IAE, 2002). The leakage of methane in run of the river plants have not yet been investigated. The WWF (2003: 4) claims that for an exact determination more research has to be done in this field, especially when the hydro technology is promoted by the UNFCCC.

### **3.2 Experiences of hydropower projects in developing countries and their contribution towards Sustainable Development**

The official development assistance (ODA) aims to help countries going steps towards the individual development of the country. Unfortunately numerous examples exist where ODA projects did not contribute to development, but to the opposite. International River Network (2004) concludes that this centralised energy source led power ministries to spend large proportions of government budgets, aid funds and institutional resources with little or even negative impact on Sustainable Development. Especially large hydropower stations have caused big problems in developing countries, for example the Aswan dam in Egypt<sup>15</sup> or Zambia and Zimbabwe where one of the world largest reservoirs (Kariba) had been built but only one fifth of Zambians and one fourth of Zimbabweans have electricity (IRN 2004).

Critique<sup>16</sup> on ODA financed projects raise today especially due to the fact that those organisations rely only on information provided by government and/or the project developer (rivers Watch et al, 2003). Wood (2003) confirms this statement showing that scooping is frequently missing, at least in so far as public consultation is concerned. Those planning mistakes lead to the fact that many potential problems are not considered and consequently more problems occur during the project phase than expected before. Some projects then become not economic anymore.

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anaerobic processes that give rise to methane. The estimated CH<sub>4</sub> emission for Swiss hydroelectric reservoirs is 1.44/10-2 g/kWh-1.

<sup>15</sup> Experts say that best way to deal with the Assuan Dam would be to destroy it, because of its negative ecologic and social effects (pers. com. Mr. Jungwirth, University of Life Science, Vienna)

<sup>16</sup> Development Disasters, critique by River Watch, IRN and FOE Japan

In many projects the lack of communication is claimed. For example at the Bujagali project in Uganda the power purchase agreement was withheld from public scrutiny (IRN, 2004). Also the World Bank (2002) claims that in “political systems that rely on closed and non-participatory traditions, it is hard to conceive of cabinet decisions or government department’s legislative proposals being open to public scrutiny”.

This leads to dissatisfaction of stakeholders, who oppose the project. A further problem is that EIA methodologies often assess the impact on sustainability poorly. Wood (2003) claims that most EIA’s are derived from developed countries and consequently not specified on the situation in developing countries. Factors such as climate, ecology, population density and social structure influence the choice of impact prediction techniques, the evaluation of significance and the design of mitigation measures in EIA.

Corruption is a further difficulty in developing countries. In the field of hydropower, corruption is taking place when plans, needs and contracts are set up for the power stations. This leads to false and unfair decisions as seen at the Bujagali hydropower station (IRN, 2003).

### **3.3 The framework for sustainable hydropower in developing countries**

As we have seen in the last chapter, a legal framework namely, rules concerning Environmental Impact Assessments is essential for developing Sustainable hydropower constructions. In developed countries Environmental Impact Analyses were established in the mid 70s (Wood 2003). This EIA legislation was adopted in developing countries, first through spot wise project examinations performed on ODA projects and then made into national law, due to pressure from donor agencies (Wood 2003). The first sustainability guidelines for major projects were developed in the early 90s, including hydropower guidelines. (World Bank 1989, OECD 1992).

Concerning SEA experience, the World Bank (2002) stated in 2002 that developing countries still have limited experience, particularly outside the context of programs and

plans financed by international aid<sup>17</sup>. Wood (2003) comes to the same result, describing very hauntingly that most EIA practices in developing countries do not work effectively due to corruption, lack of experts, expertise, money and legal basis. As EIAs in developing countries are often planned and undertaken by international consultants, the opportunity for capacity building in these countries is diminished<sup>18</sup>.

Following Wood (2003), more than 110 countries worldwide had enacted some form of EIA legislation by the mid-1990s. But laws in developing countries are usually weaker than in developed countries e.g. IRN (2004[a]: 3). The organizations showed that safeguard policies of the Government of India are weaker than those of the World Bank.

Small Scale hydropower constructions often need no EIA e.g. a CDM project in the Indian state of Himachal Pradesh where EIA is only required when the construction has a financial investment of more than 21.74 US\$ (Dehar PDD: 29). Most SSC hydropower facilities have a lower investment volume. If EIA are applied for Small Scale hydro projects, EIA procedures designed for large and complex infrastructure projects are often applied to the assessment<sup>19</sup> (Wood 2003). Wood concludes that, „too many examples exist in developing countries of mechanistic EIA reports being produced that have little or no effect on decisions ...most EIAs seem to have been a function of justifying a decision (usually to develop) that has already been made and are concerned only with remedial measures“.

Concerning CDM projects only national laws are binding and no international legislation on environmental or social issues is required (see therefore chapter 5.2). General guidelines are missing in the CDM and for project developers the CDM might be an interesting mechanism to finance projects irrespective of environmental and social standards.

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<sup>17</sup> However, there are clear signs that SEA is being studied with growing interest in many countries and some, such as South Africa, Indonesia, Chile, Colombia and Brazil (Sao Paulo State), are already developing policies or guidelines on SEA (WB, 2002).

<sup>18</sup> Additionally international consultants may not be fully independent and may be constrained by fixed budgets, the exploratory nature of EIA might be compromised (Wood 2003)

<sup>19</sup> Personal experience in India, see chapter 7.2.1

### **3.4 Positive correlation of sustainable hydro and financial benefits**

Sustainability requirements are often seen as constraints for project developers, arguing that hydropower development will not be financially attractive anymore. The general view is, that ecologic and economic goals are contrary to one another. A classical example of this conflict is the amount of rest water in diversion type plants. The more water remaining in the natural river bed and assuring a good ecological condition, the less can be diverted by the channel and goes through the turbine, creating power. IHA (2003) writes that an appropriate understanding and awareness of the complex technical, environmental and social issues inherent in a hydropower project requires far more comprehensive environmental and social studies, and this in turn has increased both project costs and lead times. But following IHA, sustainable planning will finally lead to financial benefits, due to better project acceptance and less delay of the project. Some projects that would have been technically and economic feasible in the past have turned out to be infeasible once delays and compensation costs have been factored in (IHA, 20). Those non economic projects will be faded out in an earlier stage, thus less money will be wasted on such project.

This shows that the topic of sustainable hydro has many sides. Some, especially ecologic criteria stand in contrast to financial interests while other sustainability issues, namely social ones can lead to financial benefits. Gaining financial benefits by including sustainability issues is a question of intelligent planning.

By investigating EU projects and economic effects of sustainable planning the experts came to the conclusion that financial benefits outweighed the costs of sustainable planning measures. Following an examination of 20 SEA of EU<sup>20</sup> projects, sustainable planning creates financial benefits. World Bank (2002) identifies the EU SEA benefits as:

1. Creating a better balance between environmental, social and economic factors (thus aiding the decision-making process)

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<sup>20</sup> The EU projects had been all types of projects not only hydropower projects.

2. Simplifying the process of environmental investigations<sup>21</sup>
3. Enhancing the transparency and winning public support for preferred options or strategies
4. Providing guidance on the development of mitigation proposals
5. Helping to define environmental targets for monitoring purposes
6. Avoiding subsequent delay

A functioning inter agency coordination e.g. consulting with sources beside the borrower, the implementing agency or organization, and technical experts (environmentalists, technicians, project developers...) will help lower the costs of sustainability issues. The EU study concludes that, “SEA is being used...as a logical extension to their existing strategic planning processes, and that increases in costs are regarded as marginal to the overall scale of investment...”

In addition, it is likely that the costs of SEA applications will decrease over time as SEA systems and practice get more efficient (EC 1997).

Furthermore, the benefits of sustainable hydro often occur in the long run. Benefits of EIA which initially are some of the most costly measures of sustainable planning, include good management of the environment which, in the long run will benefit the community, the project, and the nation as a whole (IHA, 2003). Further IHA found out, that an EIA will not obstruct the project. In most cases, the EIA helps to facilitate the project and agreements can usually be reached on modifying a project to the satisfaction of all concerned in order for it to proceed<sup>22</sup>. In the CDM sector, a good PDD with clear statements concerning environmental issues (EIA) and a socially sound construction will make it easier to go through stakeholder consultation, host country approval and EB registration.

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<sup>21</sup> ...and thereby reducing or possibly avoiding the need for project EIA while also accelerating the process of decision making. As mentioned in chapter environmental planning, Small Scale hydro power facilities need not necessarily an EIA in the ODA planning context.

<sup>22</sup> Only in rare cases, where the negative environmental impacts would be unavoidable and would outweigh the advantages of the project, is it found necessary to abandon a proposed project. In the long-run, such projects would typically have run into trouble anyway (IHA, 2003).



Further factors which lead to economic benefits while obeying sustainability concerns include the following:

1. Hydropower can make use of local equipment and human skills in building and maintaining a project, in general about 80% local resources in developing countries (IHA, 2003). Equipment manufactured locally, hiring the local population as workers and using local materials for the civil works is cheaper and leads to a greater acceptance of the project (ITDG, 1991).
2. Hydropower mostly employs relatively simple technology. Projects favor the self-management capacity of developing countries and avoid costly transfer of currency and local resources to developed countries once the significant initial capital investment has been recovered (IHA, 2003).
3. Run of the river projects are usually cheaper and ecologically sound than projects with dams (ITDG, 1991).
4. Using existing infrastructure, like a channel or power line, leads to lower costs and has less impact on the nature (ITDG, 1991).
5. Distribution of power to local villages e.g. low cost connection for domestic users will reduce power losses due to high voltage transformers and will also increase the acceptance of the projects (ITDG, 1991).
6. Involving the community with formation of community committees and co-operatives who are pro-active in all stages can help reduce costs as well as provide a better service (ITDG, 1991).

## **4. Reference sustainability hydropower guidelines**

Sustainable Development is development towards a better social, economic and ecologic situation in a country. As mentioned above this thesis was initially planned as a double Masters thesis. For a detailed definition and explanation of Sustainable Development and water use please refer to Burian (2005). This thesis takes existing reference hydropower sustainability guidelines defining sustainable hydro.

Performing sustainable hydropower could fail to consider one question which every country has to answer first before thinking about new hydro projects. This relates to the fact that even a very „green“ project has an impact on nature and has lead the expert group of the LIHI (2004) certification to state, “considerable concerns that ‘green’ power certification might result in accelerated development of undisturbed river systems”.

Learning from mistakes which were made with hydropower facilities and reacting on the positive correlation of sustainable hydro and financial benefits new planning methodologies for a more sustainable use of hydropower were developed in the last decades.

### **4.1 Planning methodologies**

Organisations which deal with hydropower are aware of the need for careful planning and implementation (IHA, 2003). Generally two methodologies for planning and setting up a sustainable hydropower station have to be distinguished:

1. Planning the facility with general planning, and operational guidelines (unilateral laws or World Bank policy).
2. Multi criteria decision making methodologies (World Commission on Dams).

There exists a broad consensus concerning methodologies and most international organisations (World Bank, IHA, UNEP, EU, IBRD, KfW...) have either developed their own methodologies or adopted methodologies from other organisations. In developed countries e.g. Germany, Austria, Switzerland laws for the planning of hydropower facilities prescribe a certain planning circle. Planning of hydropower

facilities must consequently proceed the below described steps, however, some organisations like IHA (2003) state that the integration of environmental and social externalities in cost and risk assessment of hydropower facilities is still insufficient.

## **1. Legislation**

Every country or every financing institute has its own legislation. Setting up a project the policy and legal framework must be determined, see e.g. World Bank requirements.

## **2. Screening**

The screening sets the frame for the Environmental Assessment (EA)<sup>23</sup>. For World Bank (1999) screening should include evaluating the project „according to the magnitude and sensitivity of the environmental issues raised. Screening determines the type of environmental analysis to be conducted for the project, ranging from a full EA to no further analysis”

Both the projects with unacceptable environmental impacts and projects lacking them completely will be „screened out“. For the World Bank the „essential part of screening is to identify which aspects of a project are not environmentally significant and which therefore can prudently be dropped from further consideration”

A good screening ensures that the necessary amount of attention is devoted to environmental aspects of the proposed project. In the early preparation process “alternatives which might be desirable from an environmental viewpoint (sites, technologies, etc.) can be considered realistically, and implementation and operating plans can be designed to respond to critical environmental issues in the most cost-effective manner”<sup>24</sup> (World Bank 1999: 5).

After screened out projects which do not need further consideration the planned projects will be arranged in three groups. The selection will be done based on conversion or degradation of critical or other natural habitats; in short the predictable

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<sup>23</sup> Before screening IUCN/EU set a pre step: Understanding the Project concept.

<sup>24</sup> Later on, making a major design change, selecting an alternative proposal, or deciding not to proceed at all with a project can become very expensive (same reference).

and assumed magnitudes of the environmental impacts of the (e.g. hydropower) project. World Bank, EBRD, KfW and others have developed an A, B, C ranking, with A for projects with the strongest environmental impacts. Each group requires different environmental assessments and considerations.

The German ministry for the environment, the responsible organisation for CDM/ JI projects made the following suggestion for classifying CDM projects in the usual A/B/C ranking (BMU 2003).

**Table 4: Classification of CDM projects into the A/B/C ranking for Environmental Assessment**

<b>A</b>	Projects, with likely strong environmental, social and developmental impact, which are mostly not locally bounded and/or reversible like large hydro. A full Environmental Assessment is required
<b>B</b>	Projects, with likely constricted environmental, social and developmental impact, which are mostly locally bounded and reversible like renewables > 15 MW.
<b>C</b>	Projects, with little or no ecologic, social and developmental impact like CDM Small Scale Projects

Following this classification, Small Scale hydropower facilities would be ranked into category B or C. However the classification is dependent on where the project is carried out. If it is carried out in or close to a sensitive area like a National Park, the project can also be classified in category A.

### 3. Scoping

Scoping sets the size of the following Environmental Assessment. For World Bank projects scoping should „occur in tandem with or as integral parts of the pre feasibility and feasibility studies“. Regardless the size of the project (A, B and C category) World Bank and IHA suggest the following steps which should only differ in the magnitude of investigations:

1. Project description: Location, objectives, clear targets and proposed indicators of success (IHA, 2004). World Bank requires a description of the project in the geographic, ecologic, social, and temporal context.
2. Baseline data: In this step it is important to state the contaminations of the river compared to the „natural state“<sup>25</sup> (BUWAL, 1997: 20). For the World Bank the baseline data must define “the dimension of the study area and describing relevant physical, biological, and socio economic conditions“. Specific inventories for acquiring better knowledge of the fauna, flora and specific habitats within the studied zone will be necessary<sup>26</sup> (IHA, 2003).
3. Public Consultation: World Bank loans require consultation for all Category A and B projects during the EA process<sup>27</sup>. The borrower must consult project-affected groups and local non-governmental organizations (NGOs) about the project's environmental aspects and take their views into account. The borrower must initiate such consultations as early as possible and consults with the groups throughout project implementation as necessary to address EA-related issues that affect them.

Bratrich and Truffer (2001) have developed the following questions for gaining an ecologic system overview:

1. Which parts of the catchment area contains intact river sections requiring conservation?
2. Which river sections have developed a significant ecologic deficit?
3. Which of these sections are affected by additional uses (flood protection, water management in residential areas, agriculture)?
4. Which sections are mainly affected by the power plant utilisation?
5. In which river reaches would a structural change significantly enhance their ecologic sustainability?

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<sup>25</sup> This state is hard to define. Following BUWAL (1997) the natural state is the state of the river before it is influenced by an agricultural and handicraft society, (like in the 19th century)

<sup>26</sup> Following the World Bank this is the most expensive part of the Environmental Assessment.

<sup>27</sup> For Category A projects, the borrower consults these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared (WB, 1999)

6. Are there river sections in which specific aspects/ individual parameters exhibit significant or extremely distinctive features in a way that requires further clarification?

#### **4. Environmental Assessment**

Depending on the gravity of the impact which had been determined in the screening process the World Bank, UNEP and others provide several tools for an EA. For large hydropower projects or projects in sensitive areas a full Environmental Impact Assessment is required. For projects which have a lower potential impact a simpler and not so cost intensive assessment is possible e.g. ranking methodologies or environmental audits. Ranking methodologies are simple check-list approach where SD criteria are defined and weighted e.g. criteria catalogues. Other options for a “small scale” Environmental Assessment are e.g. specific design criteria to safeguard the environment like “best practice” standards; environmental manuals, institutional strengthening and training or reliance on local government permit programs (World Bank 1999: 11). Those methodologies are however not very detailed.

#### **5. Assessing the options**

In the next step the different options of the hydropower project must be assessed and the decision of the optimal option will be taken. In order to compare project alternatives, key criteria should be used. IHA (2004) suggests several ranking criteria.

1. Prioritise alternatives that have multiple-use benefits
2. Prioritise alternatives that maximise opportunities for and do not pose significant unsolvable threats to vulnerable social groups
3. Prioritise alternatives that have lower impacts on rare, vulnerable or threatened species, maximise habitat restoration and protect high quality habitats.

In this step the alternative of the “project site, technology, design and operation, including the without project situation” have to be assessed (World Bank 1999). After having assessed the alternatives the decision must be justified (IHA, 2004).

## **6. Mitigation plan**

When the decision for a project has been made, the magnitude of the impacts have to be discussed (EU/IUCN, 2000). Thereby it is necessary to define solutions and measures for negative impacts as well as to identify opportunities from positive impacts. The efficiency and costs of these measures should also be assessed as well as support measures for positive impacts defined.

## **7. Monitoring plan**

Key sustainability indicators should be defined and monitored e.g the World Bank (1999) requires reports on compliance with environmental conditionality and status of mitigating.

## **4.2 Guidelines for sustainable hydropower**

The following chapter examines guidelines recommended by well known organisations for assuring sustainable hydropower. Due to different motivation and thus there are no standardised criteria like an ISO certification (Bratrich, Truffer 2001) guidelines for sustainable hydropower differ very much.

The broadest and most accepted recommendation are the World Commission on Dams and European Water Framework Directive (WFD) guidelines. The WCD report issued in the year 2000 is however designed for large scale hydropower facilities (more than 20 MW) and therefore of limited interest for Small Scale CDM projects. The WFD assesses the quality of the river by assessing the quality of water and river landscapes in Europe. This means that the WFD examines the whole river system (hydro-morphology, fishes, benthos, algae, submersed plants) and not special effects on the river like a small hydropower plant. For Small Scale hydro very few guidelines for sustainable hydropower exist so guidelines have to be derived from other documents. Documents of following organisations have been scoped.

### **Official development agencies**

Development organisations like GTZ (Germany), ADA (Austria) have developed own guidelines in the past. The Austrian Development Agency does not have predefined

hydro guidelines. Projects are evaluated on a case to case basis by independent evaluation teams (Namche Bazaar, Nepal and Rangjung, Bhutan). The German ministry for development assistance (BMZ), the GTZ can be seen as the most important contractor, has implemented EIA in all water projects since 1988. For recent projects most development organisations refers on the WCD recommendations.

### **International financing institutes**

World Bank released several guidelines for sustainable hydropower projects: Strategic Environmental Assessment in World Bank Operations 2002, Environmental Assessment Source book (EAS) 1999. The process and methodologies which are described deal rather with bigger projects and hydro projects with dams. Only general information on guidelines for Small Scale hydropower could be found<sup>28</sup>. German „Kreditanstalt für Wiederaufbau“ (KfW) published environmental guidelines for the cooperation with developing countries in 2001. Since 1998 all projects<sup>29</sup> of KfW require an EIA but no detailed EIA for hydropower is published.

### **International Organisations**

While recommendations of development and international financing institutes are comparable, recommendations of international organisations are very heterogeneous. The recommendations depend on the specific background of each organisation. Associations of hydropower developers like the European Small Hydropower Association (ESHA) or the British Columbia hydro organisation form the group with low ecologic and social standards. For ESHA (2004) aspects which “ought to be applied” include only minimum ecologic requirements like dam crossing systems and reserved flow<sup>30</sup>.

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<sup>28</sup> Guidelines dealing with smaller projects are described in chapter 9.1 of EAS.

<sup>29</sup> In Annex one it is specified that projects related with the use of water resources must have an EIA KfW 2001 based on recommendations of OECD ministry council 23.10.1986

<sup>30</sup> British Columbia environmental requirements:

- keeping deleterious material out of watercourses through slope treatments and sedimentation ponds
- fuel storage and the presence of oil spill contingency equipment
- waste collection and disposal
- emergency response plans.



The second group of International organisations active in the hydropower field aim to promote sustainable hydro. International Hydropower Association (IHA) who developed guidelines in 2004 and defined several criteria and indicators. The WCD report in 2000 focuses on framework conditions for a fair and participative decision-making process for large scale (>20MW) hydropower schemes. Although the WCD criteria are designed for large hydro the decision methodology which should assure Sustainable Development is interesting in the context of small scale CDM hydropower.

Further documents which have been taken into account are the declaration of the UN symposium on hydropower and Sustainable Development in Beijing 2004. International Energy Agency (2000) has issued the document “Hydropower and Environment; Present Context and Guidelines for Future Action”. The European Commissions “Guide to the environmental approach and impact assessment for small hydroelectric plants” defines criteria and mitigation options for small hydropower facilities. All the above mentioned guidelines will be introduced in chapter 6.3 where sustainability criteria for small scale CDM hydropower will be selected due to their specific relevance. The following sub chapter (4.2.1 4.2.2 and 4.2.3) will summarize what is the common sense concerning sustainable hydropower.

#### **4.2.1 Ecologic sustainability**

Generalizing the sustainability topic concerning hydropower is difficult due to different sites, constructions and ecosystems. As mentioned above, detailed criteria or benchmarks for sustainable hydropower are not very common and difficult as every river needs its own independent investigation. Although guidelines differ very much from organisation to organisation there is a consensus as to what is meant by sustainable hydropower. Ecologic sustainability of river hydropower can be defined with e.g. the Bratrich/Truffer (2001) definition: “Sustainable hydro secures that the river’s principal ecologic functions are preserved”.

#### **4.2.2 Social sustainability**

Contrary to ecologic or economic sustainability criteria, social criteria are much harder to define objectively, due to different personal values. Consequently criteria and quantifications for social sustainable hydropower are performed from a totally different

approach than ecologic criteria. Organisations recommend the discussion of criteria through a participatory approach based on stakeholder consultation as planning a hydropower project always involves numerous stakeholders often with conflicting interests. This implies that finally decision-makers will have to arbitrate on who will bear the negative impacts and how to compensate them (IHA, 2003).

Drawing the line of the affected people is not easy. The International Energy Agency (IEA 2000: 38) writes that, “defining who is affected by a project is a difficult exercise: Who decides? To what extent is a community affected”? This means often a negotiation “between those who legitimately believe they are negatively affected by a project and those who represent the project proponent and/or relevant public authorities“. In a social sustainable project stakeholders have to be identified and impacted communities have to be provided with the opportunity to have informed input into the decision-making process. Discussion and quantification of the criteria should be done by a stakeholder meeting. In this public consultation all positive and negative effects on the society relating with the project must be discussed in an open frame (United Nations Declaration on hydro and Sustainable Development, 2004) (IHA, 2003). Also the positive and negative effects on society like labour, energy but also gender inadequacy and on the economy like investments and infrastructure should be discussed in an open frame.

#### **4.2.3 Economic sustainability**

Comparable to social sustainability economic sustainability is hard to define. IHA (2003) writes that economic sustainability means “that project-affected people ... become beneficiaries of new development schemes”. The positive impact on income and life standard is one of the most essential indicators concerning economic sustainability for BMU (2003). Sustainability which concerns the nationwide economic sustainability like a decrease of public inventions positive impacts on balance of payments and decrease of independence of foreign currency are listed by UNEP and BMU.

### **4.3 “Green” hydropower certification**

Criteria of the above mentioned organisations are mostly not detailed enough for developing a methodological assessment of SD impacts of Small Scale CDM hydro. Bratrach and Truffer (2001) found out that existing sustainability procedures often ignore the local environmental impacts of hydropower plants completely or assess them poorly. The few procedures that already integrate local river aspects are based strictly on national legislation, thus are only of limited applicability in other countries. Dealing with this problem a detailed assessment concerning sustainable hydropower had been developed by the worldwide two certifying institutes for “green” hydro, Swiss EAWAG and the American “Low impact hydro institute” (LIHI). Those companies have developed detailed and applicable criteria for assuring ecologic hydropower and can be taken as draft for the CDM assessment.

#### **Swiss “green” hydro**

Bratrach and Truffer developed a “green” hydro certification in 2001 for the Swiss power supplier, EAWAG. The concept can be seen as the most scientific and detailed work concerning ecologic hydro assessment. The methodology had been proved already at certain Swiss hydropower facilities (Bratrach/Truffer 2001) and it is planned that the same concept will certify facilities in Austria (pers. com. M. Jungwirth, University life sciences Vienna). The concept and indicators were developed using examples of alpine storage and large Run of the River plants in Switzerland (Bratrach and Truffer 2001).

The hydropower facility has to fulfil 46 ecologic criteria and invest a fixed payment<sup>31</sup> for restoring, protecting or upgrading the environment in the catchment area. By fulfilling the requirements the facility is labelled with the “green” hydro label. Developing the concept Bratrach and Truffer designed a matrix with five management fields describing operational issues relating to hydropower generation and aspects of the facility. Those management fields comprise:

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<sup>31</sup> Of 1 Swiss Rappen (about 0,7 Eurocents) per kilowatt-hour

1. Minimum flow regulations
2. Hydro peaking
3. Reservoir management
4. Bed load management
5. Power plant design

The fields are closely interlinked and cannot therefore be considered as being separate from another. On the other hand five most important environmental fields of a river which are influenced by the plant are defined. These fields are:

1. Hydrological character
2. Connectivity of river systems
3. Solid material budget and morphology
4. Landscape and biotopes
5. Biocenose

Linking the management of a hydropower plant with the possible impacts on the environmental fields the authors defined the 46 “green” hydro criteria. Quantifying the criteria a large reference list is provided. Special attention must be addressed if a flood plain is affected or other habitats and landscapes feature require special conservation. Exceptions obeying the criteria are possible only if there is an ecologic justification.

### **Low Impact Hydropower Institute**

Developing a “groundwork for an objective standard that could be applied to small-scale facilities in Canada and the U.S” the Low impact hydropower institute set up an interdisciplinary expert team of 19 members (LIHI, 2004: 3). The members, mostly environmental experts, were asked to review 12 existing or planned hydropower projects in USA and Canada. The goal consisted in ranking the projects from an environmental perspective using a numerical scale. The first study was based on technical dossiers prepared by the facilitators. Finally the experts were asked to rank a number of variants of each project, designed to elicit a greater understanding of the

reasoning underlying their judgements<sup>32</sup>. The limited pilot study „could not set out precise rules to judge projects that fall in the grey zone between clearly „green“ and clearly not“(LIHI 2004: 35). Improving the methodology a follow up study with certification criteria had been performed in 2005 (LIHI 2005). Facilities which want to be labeled with the „Low Impact“ label have to fulfill eight criteria:

1. Reserved flow; LIHI certification requires that the reserved flow „must comply with recent resource agency recommendations for flows; if not available the Aquatic Base Flow methodology or the „good“ habitat flow level under the Montana-Tennant methodology“.
2. Water quality; „comply with state water quality standards“, and not „contributing that the river has impaired water quality“.
3. Fish passage and protection; „recent prescription regarding fish passage and fish protection“.
4. Watershed protection; „comply with resource agency recommendations, cover issues such as shoreline buffer zones<sup>33</sup>, wildlife habitat protection, wetland protection, erosion control...“ .
5. Threatened and endangered species protection; if those species are in the area, the „owner must demonstrate that the facility does not negatively affect the species.
6. Cultural resource protection; compliance with the state law or develop a plan approved by the relevant state or federal agency.
7. Recreation; comply „with similar requirements recommended by resource agencies“. and „provide public access to water without fee or charge“.
8. Facilities recommended for removal: „if a resource agency has recommended removal of a dam associated with the facility, certification is not allowed“.

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<sup>32</sup> Two of the projects were judged to be „green“ projects both Run of the River of relatively recent construction, located in steep terrain with little or no impoundments. The by-pass reach of those projects was of little ecologic, scenic or recreational importance, and the required flow in it was adequate for the needs of native species found there. So the projects had no „impacts on biodiversity or on threatened or endangered species“(LIHI 2004: 35).

<sup>33</sup> Extending about 60 meters from the high water mark.

Applying the LIHI or EAWAG certification for the CDM has several limitations. Criteria are not directly applicable in other natural regions<sup>34</sup> (Bratrich/Truffer 2001). A further limitation consists of the fact that LIHI did not define Small Scale and the group agreed to review projects as large as 80 MW. Both certifications deal only with ecological issues, criteria for social or economic sound hydro are not specified consequently applying the methodologies and criteria would result in a far too expensive assessment for the CDM hydro (further reading in chapter 6.1. and 6.2).

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<sup>34</sup> The authors point out that the certification can be used for power plants in alpine regions and similar areas in Europe but that further research is necessary if the procedure will be applied in a total different geographical region (Bratrich and Truffer 2001).

## **5. Sustainable hydro and the CDM**

Until May 2006, 36 hydropower projects had been registered. This high share of about 20% of the total registered CDM projects shows that hydropower is a very popular CDM project type. Countries with the most hydro projects are Honduras and India. The following chapter five refers to certain aspects of the CDM which are important in the discussion of hydropower facilities contributing to Sustainable Development. For a broader introduction of the Clean Development Mechanism and Sustainable Development please refer also to Burian (2005: chapter 3).

### **5.1 Benefits of CDM registration and the sustainable use of CER**

Registering a hydro project in the CDM leads to financial benefits due to selling the Certified Emission Reductions (CER). Irrespective the size of the project, the amount of CER depend on the following aspects:

1. The CER price: CER price: 5-6 Euro for medium-risk forwards, ~8 Euro for low-risk forwards, ~11-14 Euro for registered projects, around 15 Euro for Gold Standard registered projects (GTZ HWWA Newsletter, January 06)
2. The crediting period of the project.
3. The sum of reduced CO<sub>2</sub>e, depending on the baseline

An example of two Run of the River projects in India gives a rough overview of the potential benefits resulting from CDM registration. The Maujhi hydropower plant is a rather small project with 4.5 MW and a total investment of 4.8 Mio Euro<sup>35</sup> (Mauhij PDD, 2005). The amount of reduced CO<sub>2</sub> is given with 13 168 tons per year. The project plans a crediting period of 10 years. This means that the total amount of CER revenues result in 130 168 tons. Multiplying this sum with a CER price of 12.5 Euro the financial benefits of CDM registration amount to 1 627 000 Euro.

The Chunchi Doddi Run of the River plant is a comparably “bigger” Small Scale hydro facility with 10.25 MW. The investment costs range about 8 Mio Euro. The project

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<sup>35</sup> With the Euro-Dollar exchange 1 Euro = 1,19 \$, 10.2.2006

expects to reduce 25 490 tons of CO<sub>2</sub> per year. The project developer has decided to register a crediting period of seven years, while the seven year crediting period can be renewed 3 times, with 21 years in total. CER revenue of the seven year crediting period would amount 2.2 Mio Euro. From this amount the national CDM registration (in this case the Indian DNA receives 6000 Euro) must be subtracted (Axel Michaelowa, pers. comm.). Furthermore often remarkable costs of the PDD creation arise. Consequently the benefits due the CDM registration would result in about ¼ to 1/5 of the total hydro investment. Jürgen Wahl from the Austrian CDM consultant Verbundplan calculates with 12% of the total investment (Strigl, Brenzel, 2004: 47).

A signed agreement among the project participants governs the ownership of the CER. In unilateral projects the project developer team receives the CERs'. In end of pipe projects it is "usual" that a part of the money resulting from sold CERs' are "allocated", either (I) to the stakeholders, realizing "small" projects or compensation measures which aim to promote Sustainable Development or (II) to improve the environmental conditions e.g. reforestation or (III) to the government as CER tax e.g. in China (further reading in Burian 2005). In renewable energy projects like hydropower the allocation of CER benefits is handled very heterogeneously. While some projects like in Honduras want to spend all the CER for Sustainable Development activities other projects do not perform such measures. Discussing about the goal of Sustainable Development in the CDM it is essential to talk about the question how the allocation of the CER would lead to a sustainable result. Each side, the project developers, the local stakeholders and the environmentalists can claim reasonable sustainability arguments for their CER share.

Concerning implementing sustainability issues in the project, project developers argue that they have an intrinsic motivation concerning SD, as there exists a positive correlation when it comes to financial benefits and sustainability (see chapter 3.4). Small Scale hydropower facilities are more dependent on local stakeholders because they have less financial potential for public relations as well as delays of the project. Furthermore project developers argue that the CER revenues are important financial sources for a project realisation. Especially in developing countries hydropower is a difficult and risky project realisation. IHA (2003: 93ff) writes that hydro has the



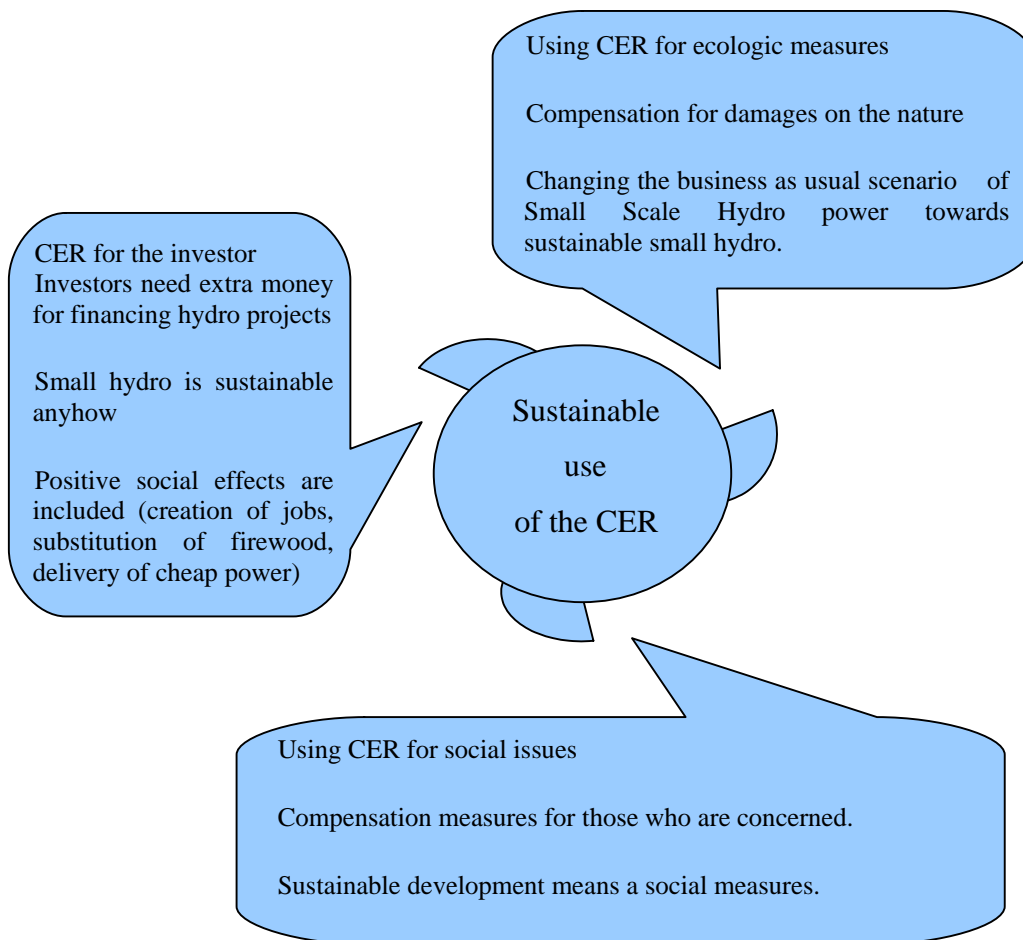
disadvantage of having high initial development costs some 100 to 200 percent higher than the thermal alternative<sup>36</sup>. Although the running costs for hydro are low, it typically has a long lead time, high capital costs and is more risky than thermal plants (IHA 2003: 93). CER revenues can decrease the investment volume, however the CDM registration raises the initial costs. Further CDM hydropower facilities are disadvantaged within the CDM in comparison to end of pipe projects (Burian 2005) and a distribution of CER would hinder the Sustainable Development goal of the CDM. Consequently without certificates there would be no promotion of renewables in developing countries and no reduction of GHG. This would not be a sustainable option.

The overall assumption of the above mentioned arguments is, that renewable energy projects contribute “per se” to Sustainable Development. As described in chapter three this does not automatically hold true. Only a sustainable hydro project remains the ecologic living conditions, at least in some extend. Local people who are directly influenced by the project might feel negative effects of a project and have somehow the right that a project in their neighbourhood does not deteriorate their living condition. Allocating a part of the financial benefits which arise out of the project would be a fair compensation. In other, more economic, words this would be an internalisation of social externalities.

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<sup>36</sup> Due to higher construction costs per unit of capacity and higher interest payments as a result of longer lead times

**Figure 3: What is a sustainable use of CER?**



## **5.2 Existing methodologies for assuring sustainable hydro in the CDM and sustainability gaps**

### **5.2.1 The existing CDM framework concerning assuring SD**

The CDM possesses a framework which aims to guarantee the positive impact on SD. This framework will be summarized in the following chapter. For a more detailed discussion of the CDM framework genesis please refer also to Burian (2005 chapter 4 and 6).

The CDM as an open mechanism invites the development of methodologies for reducing GHGs. In a second step these methodologies need to be approved by the

CDM Executive Board. Those approved and consolidated methodologies suitable for GHG reduction can then be taken over by all other project developers. Small Scale hydropower facilities can use the consolidated methodology, ACM 002<sup>37</sup>. Until the end of 2005 no methodology for large scale hydropower was registered and no corresponding decision of the EB about large hydropower was taken (HWWA, Nov. 2005). The methodologies themselves have only rules for GHG reduction and no rules for promoting SD.

The CDM framework foresees that finally the host country is responsible for the sustainability proof. This had been decided at COP 7<sup>38</sup> (Article 4 of the COP 7 decisions<sup>39</sup>): “It’s the host party’s prerogative to confirm whether a clean development mechanism project activity assists in achieving Sustainable Development”.

At the host country level members of the DNA decide if a project contributes to SD in the country. This assessment is however not very funded and mostly performed on a desktop study (see chapter 5.2.3).

Consequently the present CDM framework possesses only two methodologies which intent to assure the prescribed goal of Sustainable Development. Those are the public consultation and the stakeholder comments period. Stakeholders are defined as the public including individuals, groups or communities “affected, or likely to be affected, by the proposed Clean Development Mechanism project activity” (UNFCCC, Marrakech Accords 2002). The CDM stakeholder process takes place firstly at a local and then at a global level. On a local level the DOE is required to confirm that, “comments by local stakeholders have been invited, a summary of the comments received has been provided, and a report to the designated operational entity on how due account was taken of any comments has been received” (UNFCCC, 2002, Art. 37b).

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<sup>37</sup> <http://cdm.unfccc.int/methodologies/PAMethodologies/approved.html>

<sup>38</sup> Before the agreement that host country assessments should prove the impact on sustainable development, the position of the EU was to set up a positive list for sustainable CDM projects.

Moreover, at a global level the Marrakech Accords require that for the project validation the PDD has to be made publicly available (UNFCCC, 2002, Art. 40b) and that it shall be open for comments from the international CDM community for a period of 30 days (UNFCCC, 2002, Art. 40c).

As stakeholders have direct connection to the hydropower facility and negotiate for a ecologic and socially sound project the CDM can be seen as a transparent mechanism. Mr. Sethi who has been elected to the Executive Board and head of the Indian DNA's sees the framework requirements as sufficient<sup>40</sup>. However bearing in mind the huge potential of negative impacts of hydropower facilities listed above, the methodologies in the CDM framework are not enough for assessing the Sustainable Development impact. The following chapter will point out the deficiencies in the existing CDM framework and the need for an improved methodology will become clear.

### **5.2.2 Structural dysfunction**

Burian (2005 chapter 5.1.3) described differences concerning the approval requirements in host countries, which can lead to the danger of the race to the bottom concerning sustainability issues. The country with less sustainability criteria will more easily approve a project and attract financial capital in comparison to a country having more detailed sustainability criteria. Burian showed further a dysfunction in the CDM which affects renewable energy projects. The projects are disadvantaged compared to end of pipe projects with regard in investment costs and the issued amount of CER (Burian 2005: 53ff). An end of pipe project has the advantage (I) of lower investment costs (II) proving more easily the additionality and (III) a much higher rate of CER per invested capital.

Levelling the disparities DNAs' seem to have different demands for the host country approval concerning the two project types (Burian 2005: 53). Those different demands

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<sup>39</sup>[http://unfccc.int/resource/docs/cop7/13a01.pdf#search=%22COP7%20%20\(Article%204%20of%20the%20COP7%20decisions%22](http://unfccc.int/resource/docs/cop7/13a01.pdf#search=%22COP7%20%20(Article%204%20of%20the%20COP7%20decisions%22)

<sup>40</sup> Personal communication with Mr. Sethi (DNA India) June 2005: the project cycles ensure already the contribution of the projects to Sustainable development. All other requirements are not necessary and costly.

one can see in (I) taxes for end of pipe projects<sup>41</sup> (II) easier additionality proof for renewable energy projects or (III) approving renewable energy projects as per se sustainable with no further sustainability check.

The sustainability check is mostly performed in a short time on the desktop (see chapter 7 India) Finally the only judges (as mentioned above in many countries Small Scale hydropower facilities need no EIA<sup>42</sup>) of Sustainable Development will be the stakeholders. Assuming that the stakeholder process will run in an open and fair atmosphere, the assessment can still fail to create Sustainable Development impacts. As we have seen in chapter 3.4 social concerns have positive correlations with financial benefits. Consequently some social concerns can find automatically an implementation in hydropower planning<sup>43</sup>. Stakeholder opinions which have trade offs with hydro interests can be appeased with compensation measures negotiated in the stakeholder process.

In contrast to ecologic criteria. A stakeholder consultation as single judge of Sustainable Development will most likely find a social and economically sound agreement. Ecologic issues will hardly find implementation in the project as no strong voice negotiates in favour of the environment.

### **5.2.3 Communication and stakeholder consultation**

Chapter three described the need of a cooperative project implementation to promote Sustainable Development. The establishment of a “level playing field” in the CDM with different stakeholder groups like governments, public utilities, the private sector, NGOs’ has to be strengthened. According IHA (IHA[a] 2003: 14)<sup>44</sup>. It is essential to „encourage the development of a market and regulatory environment that fully accounts for externalities like air pollution costs, natural resource depletion and societal benefits like flood control, water supply, recreation, navigation, ancillary services”.

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<sup>41</sup> China has a HFC tax

<sup>42</sup> Or the EIA is not performed in a good manner see e.g. chapter 3.3 or EIA for CDM project Chunchi Doddi.

<sup>43</sup> Like for example hiring of local workers.

<sup>44</sup> The idea had also been outlined by the United Nations Department for Policy Coordination and Sustainable development. 1995.

However the stakeholder consultation faces deficiencies both at the local and global level aiming to assess project impacts. Sometimes despite the obligation of the CDM framework stakeholder consultation are not even performed. The Mauhij/India hydro project (PDD page 30) claims: “As described above, the main stakeholders for the project are the local populace represented by the Village Panchayat, GoHP<sup>45</sup> and ERCHP<sup>46</sup>...The project proponents M/s Dharmshala hydro Power Ltd. had involved all the stakeholders for setting up the 4.5 MW Maujhi small hydroelectric project and had extensive discussions with the above stakeholders well in advance before implementing the project.”

However when the author visited the Mauhij project the villagers claimed that no stakeholder consultation was held in the village. This statement was confirmed by responsible from CDM-India in Delhi.

Furthermore local people are mostly not educated enough to judge and raise concerns. Investigating hydropower facilities in the U.S and Canada performed by LIHI experts concludes that the „lack of essential information in many of the projects dossiers...contributes to limit the effectiveness“ of judging sustainable projects from others (LIHI 2004: 36). While the LIHI environmental experts had detailed project dossiers the situation in the CDM is worse. Information concerning sustainability in the PDD is rare and furthermore there are generally no environmental experts in the consultation process.

The online public consultation lacks similar problems. The consultation takes place after the project had been validated. This means that project relevant decisions have already been taken and comments are rather unlikely to be introduced into the project planning. Sometimes questions are even ignored in the online consultation. The author of this thesis requested the EIA of the 5 MW Dehar project in Himachal Pradesh, India (registered 18. July 2005). In the PDD it was written that the EIA had been done and

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<sup>45</sup> Government of Himachal Pradesh

<sup>46</sup> Electricity Regulatory Commission of Himachal Pradesh

could be seen on request. During the online consultation, the author received no answer from the DOE, the TÜV Rheinland.

Verificators (e.g DNV, TÜV Süd) do not inspect the EIAs' or guide the stakeholder process. According to personal communication with a certifying company at the Carbon Expo 2005, the impact on Sustainable Development is guaranteed when the project receives the Letter of Approval from the DNA. This leads further to the problem with the control of compensation and mitigation measures. According to EU/IUCN (2000) the monitoring of EIA decisions and mitigation measures is an important issue and past experiences show that this was the weakest link in the EIA process. So one can conclude that steps have to be undertaken to establish the "level playing field" in the stakeholder process leading to fair decision making.

#### **5.2.4 Decision making**

As mentioned above the money resulting out of the CDM registration is 12% (Brenzel/Strigl 2004: 47) of the total hydropower investment. Consequently the project developer has to finance and plan a project only marginally bearing in mind the additional money and requirements (stakeholder process) of the CDM registration. For this reason the influence of the stakeholders concerning modification or rejection of the project is very low, when the decision of the realisation of the project has been made in earlier stages. The project developer will not agree on undertaking costly modifications or alternatives. Such a flawed assessment of alternative or modified options of hydro projects had also been criticised in the WCD (2000) final report. In some countries however project developers have to plan with stakeholder consultation as it is prescriptive law irrespective of CDM registration.

When it comes to host country approval the DNA decides on the desktop if the project contributes to Sustainable Development. Section F and G of the PDD provides environmental and socially relevant information. The author conducted a study about the DNA approval requirements on the Carbon Expo 2005 in Cologne. The result was that most requirements for the approval were very general and DNA has mostly limited time and knowledge to assess the impact on Sustainable Development of a project. Only some DNA, like Uruguay (Sutter methodology), India (PCN), Malaysia,

Cambodia (adopted SSN tool) have developed a more detailed host country approval<sup>47</sup>. which however in the case of India does also not lead to satisfactory results (see chapter 7).

This arbitrary DNA approval methodology can also lead to disadvantages for the project developer. The developers do not know which sustainability criteria are important for the DNA and the letter of approval becomes a questionable matter. Projects might be refused although they are sustainable. However in most cases it seems to be that projects get approved irrespective of their potential negative Sustainable Development impacts.

To deal with that lack of operable sustainability evidence in the CDM several methodologies for improving this situation have been developed. Three different methodologies have been developed by WWF in cooperation with other NGOs', South South North and Christoph Sutter. These methodologies will be introduced in the following chapter.

### **5.3 Voluntary methodologies for assuring the Sustainable Development impact**

This chapter will provide a short overview of the South South North assessment methodology and MATA. For a detailed investigation into those two methodologies please refer to Burian (2005: chapter 6.1 and 6.3). Only the Gold Standard which has developed a specific method of hydro assessment will be assessed in detail.

#### **South South North (SSN)**

The south African non-profit NGO has developed an assessment procedure which consists of an eligibility screen, a Sustainable Development test and an additionality test. SSN aims to appraise and rate “projects at the time of project design and approval” and to guide the DNAs' evaluation of the contribution of projects to Sustainable Development (Burian 2005: 62).

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<sup>47</sup> Personal communication Dr. Axel Michaelowa, Hamburg Institute



For assessing the impact on Sustainable Development a project is tested with the “Sustainable Development Appraisal & Ranking Matrix Tool”. The Appraisal & Ranking Matrix Tool consists of three “pillars” which cover social, economic and ecologic impacts. The impacts are screened with a fixed list of indicators<sup>48</sup>. The Tool scores the indicators with ranges from -2 to +2, whereas the subtotal of each pillar needs to score at least -1, while each indicator must score better than -2.

The SSN indicator-matrix which was also adapted by the Gold Standard (Burian 2005: 62), is however left without quantification. To illustrate this imprecise assessment one has to imagine assessing an indicator like “impact on air” or “impact on water quality” with a range of -2 to + 2 without benchmarks. Without this orientation the indicators can only be assessed very roughly. Burian (2005: 65) concludes that “as a consequence of the great range of application, SSN chose broad indicators to assess Sustainable Development. As indicators cover a wide range of aspects and since they are quantifiable, they can be considered to be well chosen. But the indicators are too general in order to quantify project impacts precisely and consistently”.

Sutter (2003: 39) criticised that all indicators deserve the same weights which does not necessarily reflect decision maker values. The Matrix Tool can be seen as a step forward in the Sustainable Development assessment, but is not able to assess a project specific impact with regard to sustainability.

### **MATA assessment**

Christoph Sutter, who developed the MATA assessment, is an expert in evaluating projects in Non-Annex I countries. In his book “Sustainability Check-up for CDM” Sutter introduces a decision-making Instrument to assess CDM projects, called Multi-Attributive Utility Theory for CDM Assessment (MATA-CDM). MATA is based on the open multi-criteria decision-making approach<sup>49</sup> and focuses on being applied by DNAs.

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<sup>48</sup> For a detailed discussion on advantages and disadvantages of predefined indicator lists versus open discussion solutions please refer to chapter 6.1.

<sup>49</sup> MCDM are discussed in chapter 6.1

The advantages of MATA-CDM consist in reflecting the multi-dimensionality (Sutter 2003: 74) of Sustainable Development because MATA-CDM deals with multi objective and multiple decision makers (Sutter 2003: 76). Secondly it reflects subjectivity of Sustainable Development because local stakeholder can participate in the stakeholder procedures and thereby influence the assessment outcome.

The MATA-CDM consists of five steps<sup>50</sup>. In the first step criteria which reflect environmental and living conditions as well as project impacts<sup>51</sup> have to be identified (Sutter 2003: 80) while in the second step indicators assessing the criteria are defined. Those indicators can be quantitative, semi-quantitative or qualitative while quantitative indicators use a cardinal scale to assess impacts (Sutter 2003: 82). The indicators will be transformed into a utility function whereas the function varies from -1 to +1 in order to reflect positive or negative project impacts compared to a baseline. In a third step, criteria and indicators have to be defined through an assignment of weights. The weighing of an indicator should reflect the arithmetical average of preferences<sup>52</sup> of all stakeholders (Sutter, 2003, 86).

Once the first three steps are completed, the methodology is ready to be applied to CDM proposals in a fourth step. Project ratings are aggregated to a number that should represent the total utility of a project during the crediting period with regard to Sustainable Development (Sutter 2003: 91). The MATA-CDM employs an additive model to aggregate utilities from indicators which implies that a weak indicator can be compensated through a high scoring of other indicators. Minimum utility levels for criteria can be defined in order to exclude massive and irreversible negative project impacts.

The fact that no fixed set of criteria exists allows a feasible implementation, but at the same time this bears the risk of an inadequate adaptation to a specific situation. In bigger projects, taking all stakeholder interest into account may turn out to be difficult

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<sup>50</sup> For an overview about steps and their central equations please refer to Sutter (2003: 79) or Burian (2005: 65).

<sup>51</sup> Arranged to the three pillars of Sustainable development.

as impacts of projects are not only limited to the local environment but may also affect more distant regions. Moreover, even if all of these interest groups are represented, a pure stakeholder approach will ignore needs of future generation's positions and an intrinsic value of nature. Furthermore the MATA-CDM strongly relies on the approving body. DNAs' are responsible for choosing criteria, indicators and for generating the utility functions.

### **The Gold Standard**

Among the sustainability methodologies the Gold Standard (GS) is the most recognized instrument for assessing CDM projects<sup>53</sup>. The GS is attended by a technical advisory board and promoted by a sustainable energy institute, BASE<sup>54</sup>. Until June 2006 four GS projects had been registered. The GS is valued by certifying companies such as the DNV or TÜV SÜD, however selling the GS seems to be a hard work<sup>55</sup>. According to the GTZ/HWWA Newsletter (January 06) the price for GS-CER is around 15 Euro, 2-3 Euro more than the normal CER price.

The GS aims to create premium credits for CDM projects by both better stakeholder consultation and explicit sustainability criteria. The main focus for creating real sustainability benefits, according to the GS is "adequate stakeholder consultation" (The Gold Standard, 2003: 6). Consequently the GS prescribes wider public participation procedures than the usual CDM-requirements. Regulations for stakeholder consultation are based on international current guidelines such as the International Finance Corporation regulations (Langrock, Sterck, 2003: 8). In order to fulfill GS stakeholder requirements "comments must be actively invited" (The Gold Standard, 2005: 18) and meetings need to be carried out in local languages (The Gold Standard, 2005: 18). Furthermore in the course of the consultation process an Environmental and Social Impacts Checklist must be addressed (The Gold Standard, 2005: 15ff). This procedure ensures adequate information of local stakeholders about project impacts and the idea of Sustainable Development. Finally stakeholders can influence the decision-making

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<sup>52</sup> Using the arithmetical average of preferences implies that all stakeholders are equally affected from project impacts.

<sup>53</sup> For more information about genesis and methodology of the Gold Standard please refer to Burian (2005: 62).

<sup>54</sup> Basel Institute for Sustainable Energy

process by conducting an EIA (The Gold Standard, 2005: 11). In addition to the assessment following questions have to be answered with “Yes”:

1. Have alternative technologies, sites and resource uses been given due consideration?
2. Was the identification of environmental and socio-economic impacts deep and broad enough and did the assessment cover an appropriate area of influence?
3. Did public consultation begin early enough to ensure that stakeholder views were incorporated in the design of the project activity?
4. Are any proposed impact mitigation and compensation activities credible and feasible?
5. Is the monitoring plan appropriate and feasible?

The second pillar of the GS methodology consists of an assessment procedure for each project. In the same way as above, regulations of multilateral institutions like OECD, EU, World bank have been implemented to develop this concept (JIKO, 2003: 9). The GS aims to lower the costs by a completion of the table without new research (The Gold Standard 2003: 24). Quantitative data should be required from official governmental reports or international sources like UNDP<sup>56</sup> (The Gold Standard 2003: 24). The project’s sustainability is assessed using a scoring system, similar to the SSN scoring, ranging from -2 for major negative impacts, 0 with negligible impacts and +2 with major positive impacts (The Gold Standard 2003: 23). Every sub-group (environmental, social and economic) must have a positive value (The Gold Standard 2003: 23). Finally all data and statements are checked by the valutors (The Gold Standard 2003: 24).

For hydro projects<sup>57</sup> a specific GS-EIA has been developed which must be applied if such a measure is claimed in the stakeholder process<sup>58</sup> (The Gold Standard 2003: 34).

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<sup>55</sup> Pers. com. with Michael Rumberg (TÜV Süd) at Carbon Expo: Until March 2005, the interest in TÜV Süd Gold Standard certification stopped in all cases after the first phone call.

<sup>56</sup> The Gold Standard recognises that many of the indicators suffer from a lack of basis data of the current situation (The gold Standard 2003: 24).

<sup>57</sup> The GS registers only small scale hydropower facilities with less than 15 MW (The Gold Standard, 2003: 18)

The EIA consists of a catalogue which defines environmental and social aspects of Run of the River plants (The Gold Standard, 2003: 23).

**Table 5: Gold Standard criteria for CDM Run of the River projects EIA**

<b>Management domain</b>	<b>Basic requirements</b>
<b>Minimum Flow</b>	<ul style="list-style-type: none"> <li>- Goal is a dynamic flow regime, which qualitatively simulates the natural hydrological regime</li> <li>- Minimum flow which guarantees habitat quality and prevents critical oxygen and chemical concentrations</li> <li>- No disconnection of lateral rivers</li> <li>- Minimum water depth for fish migration during critical periods</li> <li>- Lateral and vertical connectivity shall not to be substantially disturbed</li> <li>- Provides sufficient transport capacity for sediments</li> <li>- Landscape compartments shall not be destroyed</li> <li>- Flood plain ecosystems shall not be endangered</li> <li>- Conservation of locally adapted species and ecosystems</li> </ul>
<b>Hydro-peaking</b>	<ul style="list-style-type: none"> <li>- Rate of change of water level should not impair fish and benthic populations</li> <li>- Reduction in water level should not lead to drying of the water course</li> <li>- Protective measures if flood plain ecosystems are impaired.</li> <li>- No isolation of fish and benthic organisms when water level decreases</li> <li>- No impairment of spawning habitat for fish</li> </ul>
<b>Reservoir management</b>	<ul style="list-style-type: none"> <li>- Are there feasible alternatives to reservoir flushing?</li> <li>- Changes in reservoir levels should not impair lateral ecosystems (flood plains..)</li> <li>- Connectivity with lateral rivers should not be impaired</li> <li>- Sediment accumulation areas should be used as valuable habitats, where feasible</li> <li>- Special protection of flood plain ecosystems if they are impaired</li> </ul>
<b>Sediment management</b>	<ul style="list-style-type: none"> <li>- Sediments have to pass through the power plant</li> <li>- No erosion and no accumulation in the river bed below storage dams and water</li> </ul>

<sup>58</sup> If stakeholder however require no EIA the project is assessed with the usual GS “sustainable development Assessment” (SDA).

<b>ment</b>	intakes because of a deficit in sediments - Sediment transport should sustain typical river morphological structures - No accumulation of sediments below dams - River habitats have to be established
<b>Power plant design</b>	- Free fish migration upwards and downwards (as far as technologically feasible) - Protection of animals against injury and death stemming from power plant operations (turbines, canals, water intakes, ...)
<b>Social Impacts</b>	- Cultural landscapes - Human heritage (including protection of special ethnic groups) - Preservation of lifestyles - Empowerment of local stakeholders in the decision-making process (about mitigation and compensation of social impacts) - Resettlement of local population under similar or better living conditions (than prior to the project) - Build additional social infrastructure, sufficient to cope with population increase (due to migration induced by the project) - Water quality and fishing losses affecting downstream riverside population

### **Problems of the GS**

Dealing with the above discussed lack of sustainability in the CDM, the GS provides steps forward towards assuring Sustainable Development in the CDM. The stakeholder process is a well developed tool for guaranteeing social sustainability. Aiming to facilitate and improve the GS, the methodology should be elaborated on some aspects. Namely the complexity of the tool has to be reduced and indicators for the assessment have to be more precise and where possible quantified. Can both goals be reached together?

Applying the general GS indicators (see Annex) to all project types makes the assessment both tiring and imprecise. Langrock and Sterk (2003: 15) criticise the GS system being both too restrictive and extensive. Aiming to reduce the volume and complexity of the method, the Gold Standard should focus on specific projects types and define specific indicators for each type.

Defining specific indicators had been tried with the hydro EIA, which is a step forward but must be improved in some aspects. Several criteria listed in the catalogue are not necessary in the context of Run of the River facilities, namely the whole sections of hydro-peaking and reservoir management (10 indicators). For a clear and easy application the catalogue must be as detailed as possible for the specific projects. Additionally the catalogue should have indicators which are as detailed as it is possible for a global assessment. Hence an impacted community has an orientation which aspects are important and how they can be negotiated. Last but not least the list should have an element of adaptation and declaration of individual values.

A second problem of the GS EIA consists that the EIA will only be performed if it is wished by stakeholders. Bearing in mind the above listed problems concerning the assessment of Sustainable Development in the stakeholder process, it will be more helpful to address minimum requirements to all hydro projects. Project specific criteria catalogues for all CDM projects would level the demands for the GS certification (Langrock/Sterck 2003: 15)<sup>59</sup>.

#### **5.4 Sustainable CER buyers**

The mechanism of the CDM possesses a total investment volume of 1.1 billion Euro (PCF Presentation on Carbon Expo, May 2005). The field of the buyers for the certificates (CER) is very heterogeneous. While some companies or investment funds look for cheapest CO<sub>2</sub> emission reduction other buyers/funds want exclusively contribute to Sustainable Development in the host countries and accept a higher price for CER. Promoting sustainable projects can only be assured on a voluntarily basis by buying certified “green” CER, such as GS CERs`. The premium CER market is still a niche market (Axel Michaelowa pers. comm.) but the promoters have ambitious goals (see Gold Standard Homepage). Hence a the focal point assessing the potential for certified „green“ hydro is to investigate the interest of the CER buyers’.

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<sup>59</sup> The hydro assessment system has also been criticized because such a detailed tool had only been developed in the GS for hydropower projects (Jiko 2003: 15).

Different buyers have expressed their commitment towards sustainable projects using their own SD guidelines e.g. the World Bank has set up the Community development Carbon Fund which aims explicitly promote SD by buying only CER resulting out of renewable energy project activities ([www.pcf.org](http://www.pcf.org)). The managers<sup>60</sup> of the biggest carbon Fund, the World Bank “Prototype Carbon Fund”, released a joint announcement addressing the application of Bank safeguard policies to operations of the Prototype Carbon Fund, or any other Bank-managed carbon finance operations (see [www.pcf.org](http://www.pcf.org)). In this announcement they state that „Task Team Leaders should process projects in a manner fully consistent with the application of all Bank policies including of course safeguard and disclosure policies“.

The German ministry has also defined own indicators for sustainable CDM/JI projects. Those indicators aim to assure that only sustainable CER will be bought. They are defined as: air pollution, noise, soil movement, climate change abatement, reduction of local and regional impacts on the environment (e.g. inundation), reduction of the use of non renewable resources and maintaining biodiversity (BMU 2003: 16). Assuring the positive impact on Sustainable Development will be then assessed by an investigation if the host country has explicit sustainability criteria which are comparable to World Bank, EBRD ...standards (BMU 2003: 20). If this holds true projects are measured with host country criteria. If the host country has not a developed SD check or if the approval differs from international guidelines, the international guidelines must further be applied (BMU 2003: 17). This is a good approach towards SD, however the ministry does not tackle how the differences between host country specific and international guidelines are measured.

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<sup>60</sup> Ken Newcombe and Stephen Lintner

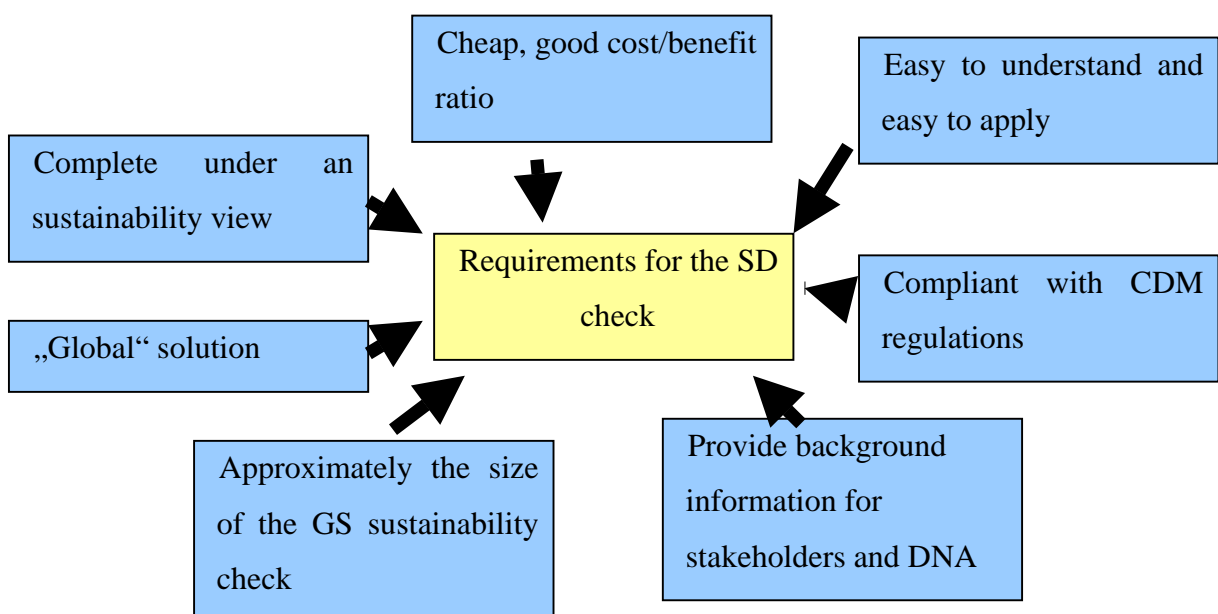


## 6. Towards a methodology for assessing the impact on Sustainable Development of CDM hydro projects

In this chapter a new methodology to assess the impact of hydropower facilities on Sustainable Development will be drawn up. Chapter three has provided reference sustainability guidelines (ODA, NGO, IFC), “green” hydropower certifying indicators and experiences of ODA hydro projects. The information will be screened with the focus on the applicability for a sustainability assessment and experiences from the field study in India will provide further important information input. Conditions which have an important influence on the selection of sustainability criteria as (I) CDM regulations (described in Chapter 5) (II) the motivation, both of the DNA and project developer to promote projects contributing to SD and (III) the existing voluntary methodologies where synergies should be used instead of inventing a new procedure (chapter 5.3) give the frame of the methodology.

Consequently the whole methodology as well as the amount of criteria must be (I) cheap (II) complete with regard to ecologic and social sustainability (III) easy to apply and (IV) have approximately the same dimension as the Gold Standard methodology.

**Figure 4: Requirements for an Sustainable Development check**



The first chapter, 6.1 deals with general requirements like the design of the methodology followed by economic considerations analysing the costs of a sustainability methodology. The recapitulating chapter 6.2 provides a planning and decision-making process and secondly the methodology an hydropower Sustainable Development assessment will be presented.

## **6.1 Requirements for an assessment methodology**

Defining sustainability criteria for Small Scale hydropower in general is a difficult task due to the fact that hydropower constructions are very different in design. Each design and hydropower use leads to different ecologic, social and economic impacts (EC, 1998: 5). The following designs and methodologies can be distinguished (EC [d] 1998: 5).

1. Diversion type facilities or river power plants
2. Facilities with peaking operation
3. New versus existing facilities
4. Multi purpose versus single hydropower stations

Furthermore the difference in the natural potential, e.g. if the facility is in a natural sensitive area, as well as the size of the population impacted by the project is essential in the SD context. Dealing with this heterogeneity a sustainability methodology must either possess very general criteria for covering all types of Small Scale hydropower facilities or focuses on special plant types e.g. World Bank's (1999) good practice statement includes a list of projects that will usually require an environmental assessment. Too detailed criteria however result in high costs and problems with comparisons over time and place. Aiming to be a simple and fair assessment for hydropower facilities this thesis focuses only on Small Scale Run of the River facilities and River Power Plants.

A second important requirement concerning the methodology consists in the correspondence with the CDM framework legislation. As mentioned in chapter five the DNA is the responsible body for the sustainability proof. Consequently a methodology

for sustainable hydropower can presently be implemented only in a DNA approval or on a voluntary basis such as the Gold Standard. In chapter eight possible implementations in the CDM will be discussed in more detail.

### **MCDM tools versus Criteria Catalogue**

In developed countries mostly multi criteria decision making (MCDM) tools are applied (Nachtnebel 1995, TIWAG 2005). Multi criteria decision-making tools (MCDM) like e.g. the MATA assess on a project to project basis. While different stakeholders express their specific ideas on SD in the decisions making process, MCDM have the advantage to be flexible<sup>61</sup>, site specific and objective (Nachtnebel 1995). So why not using MCDM in the CDM?

Several authors like Wood (2003) or DIW/HWWA (2004) claim that in most developing countries the legal framework, lack of institutions as well as the lack of knowledge of the civil society leads to conditions that do not favour public participation and public decision making. This holds true especially in rural areas where most Small Scale power stations are built.

MCDM methodologies need balanced stakeholder groups. As criticised in chapter 5.4 existing assessment methodologies e.g. SSN or Gold Standard lead to imprecise results when no detailed benchmarks are predefined. The first step to improve the stakeholder process is to support stakeholders with information on impacts of hydropower facilities. They need clear criteria and indicators for Sustainable Development as well as approximate quantification, so that they can judge possible impacts.

MCDM methodologies are more complicated and time-consuming. Anne Schuster from GTZ (DIW/HWWA 2004) said that with regard to the applicability of WCD guidelines most developing countries wish more simple check-lists. Otherwise the responsible administration like e.g. the DNA have somehow to interpret sustainability criteria and their relevance (DIW/HWWA, 2004). Methodologies have to be easy to apply and understandable but nevertheless complete. All dimensions must be reflected

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<sup>61</sup> Which is good for an ex ante assessment; to discuss criteria which have to be addressed.

through the set of indicators. IHA (2003) stresses that an impact assessment must consider local, regional and global perspectives as well as the issues of construction, operation and life cycle of the plant (EC [d], 1998: 17).

MCDM methods assess different alternatives of one project and want to find the best project out of the alternatives (Bogardi, Nachtnebel, 1991). In the CDM stakeholders or DNA's have to choose the contribution to Sustainable Development of a project and not alternatives or options.

Lists of predefined criteria or specific projects types or sizes which need an EIA have the problem that ultimately it is the significance of the impacts and not the type or size that determines the negative impacts on the environment<sup>62</sup>. However several ODA organisations like World Bank or GTZ point out that especially the practicability of sustainability methodologies is very important in developing countries. For the special case of sustainable Small Scale CDM projects a combination of predefined criteria and open negotiation decision seems to be the best methodology. Such an approach requires on the one hand predefined criteria with clear and simple indicators assuring especially the ecologic issues. On the other hand the fact that every project is in a different social economic environment and that people have to express their development priorities makes it necessary to discuss qualitative issues in an open stakeholder process like recommended by World Commission on Dams or Sutter.

Dealing with the lack of data is challenging work in developing countries as following Wood (2003: 12) baseline socio-economic and environmental data may be inaccurate, difficult to obtain or non-existent. Sutter recommends the application of qualitative indicators to "those criteria where a quantitative assessment is not possible or where sufficient data is not accessible" (Sutter, 2003, 83f).

The criteria catalogue proposed here will thus be a simple methodology with no ranking and a stock of sustainability indicators which have to be assessed. With the following open stakeholder negotiation process this catalogue has the ability to be

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<sup>62</sup> With that argument the WCD guidelines are criticized by several European hydropower developers.

adapted to project specific situations, like individual conditions of the socio-ecologic and economic environment. Social criteria are left without quantification.

Such a criteria catalogue provides information for the local people and can directly be implemented as a check list in the most important voluntary sustainability methodology, the Gold Standard. Further this catalogue can give a hand to DNA members in implementing the indicators in the host country approval assessment. Finally indicators can be used as input for a the more complex and complicated methodologies such as MCDM like MATA.

## **6.2 Economic considerations of sustainable CDM hydro**

Developing a small and cheap criteria catalogue, it is important to investigate both the financial costs in total as well as the specific costs of each criterion and measure. Additional costs for a sustainable hydro facility result out of both, initial sustainable planning and construction measures as well as sustainability rules like e.g. restwater. Due to the influence of the local stakeholder in the decision-making process costs for the project developer for Sustainable Development issues vary from project to project. In developed countries 90 % of the costs for a sustainable project arise from the use of internal staff time, payments for expert advice and consultancy time (World Bank, 2002: 28<sup>63</sup>).

Cost estimations of the Swiss „green“ hydro certification is not directly applicable to the CDM for two reasons. Firstly the certification methodology is very detailed and focuses only on ecologic issues. Secondly the price structure in Switzerland is not comparable with developing countries. However cost estimations performed in the year 2000 for Swiss “green” hydro certification can give a rough overview. The cheapest certification would result in costs of approximately 24.000 Euro while highest costs range at about 50.000 Euro (Bratrich/ Truffer, 2001: 107). The largest sum which has to be paid in all cases (about 20.000 Euro) results due to the prestudy and management

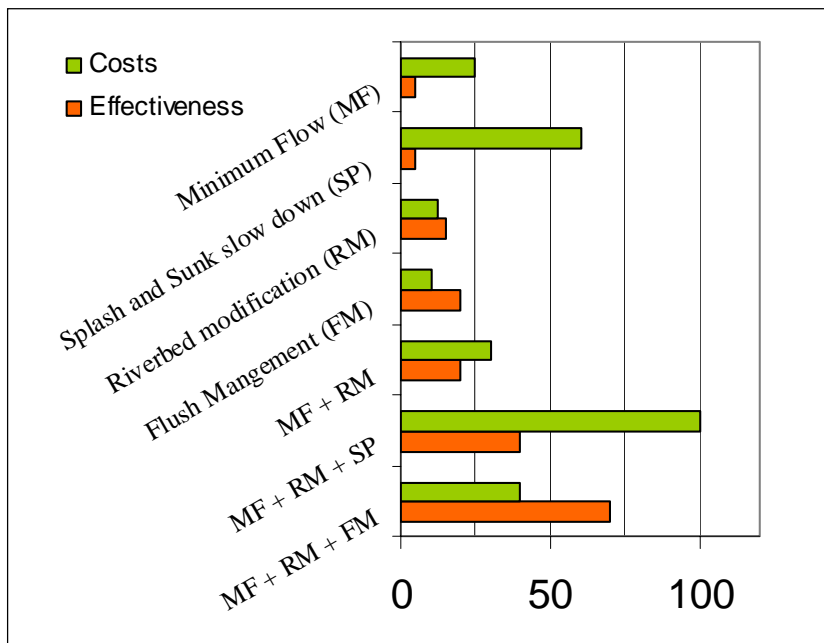
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<sup>63</sup> Referring on an EU report.

concept (Bratrich/Truffer, 2001: 107). In the highest cost scenario most of the money is spent for measurements fulfilling the basic requirements<sup>64</sup>.

Different measures have specific cost-effectiveness ratios. Table 8 shows possible combinations of measures which correspond to different cost-effectiveness ratios (adopted and modified after Schmutz, 2005).

**Figure 5: Combinations of ecologic measures, different cost-effective ratios<sup>65</sup>**



From a cost effectiveness viewpoint the combination of the measures for Minimum Flow together with measures of the Riverbed Modification and Flush Management shall be given priority.

<sup>64</sup> Naturemade star costs estimation for the Bratrich/Truffer „green“ hydro certification.

<sup>65</sup> Splash and sunk occurs at sand trap flushing.

### 6.3 Selection of sustainability criteria for CDM hydro projects and their relevance

Chapter three has provided an overview of hydropower guidelines. In this chapter criteria will be selected concerning their specific relevance for assessing the impact on SD. The question which will be answered here is: Why is this criterion important in the context of SD at CDM hydro projects?

The framework conditions described in the last chapters hopefully made clear that the implementation of sustainability criteria is reduced by the motivation of the responsible as well as financial constraints. Consequently it is important that a methodology for sustainable development assessment focuses only on the most important criteria, without losing its completeness. A small and cheap catalogue with most important criteria has the biggest chance to be implemented in the CDM. Following criteria had been selected due to their high ecologic relevance for Run of the River and River facility types. Under an ecologic or social viewpoint this catalogue can be seen as minimal requirements.

**Table 6: Selected criteria for a sustainable development assessment for small scale CDM hydropower facilities and their relevance**

<b>Criterion</b>	<b>Relevance</b>
<b>Three dimensional connectivity of the river</b>	The longish (river continuum, lateral rivers), vertical (river bank, flood plains and surrounding) and horizontal (ground water) connection of the river. Conservation of natural river bed structure.
<b>Sustaining morphological river conditions</b>	Sediment transport should sustain typical morphological structures. Riverbed must remain a sound living system.
<b>Reduced impact on ecosystem</b>	Maintain biodiversity: species diversity, habitats diversity, genetic variability.
<b>Impact on local community</b>	New projects have an influence on lifestyles, local economy, human capacity and gender issues.

<b>Impact on public health</b>	Water related diseases may occur, construction safety.
<b>Impact on local economy</b>	New investments have direct influence on jobs and income as well as macro economic impacts.

### 6.3.1 Ecologic criteria

Selecting ecologic indicators for sustainable hydro assessment or monitoring it is important to focus on abiotic indexes which are much easier to measure than biotic ones. Those give nevertheless an account of the impact on the environment of an action (Hütte, 2000).

#### **Three dimensional connectivity of the river**

Sustaining the longish connectivity is one of the most important factors when a new hydropower plant is built. In diversion section hydro plants, the connectivity of the river must be assured with a residual flow (ecologic flow) in such a way that it is healthy for fish and wildlife (e.g. LIHI: 2005). River power plants need a fish bypass. Furthermore lateral rivers must not be disconnected and the connectivity with flood plains and groundwater should not be substantially disturbed.

The connectivity is essential for a living ecosystem. Also for reasons of human water withdrawal it is important to feed the underground waters (ESHA 2004). The Austrian Water Law from 1990<sup>66</sup> states that water withdrawal is only justified if the functionality of the river remains. The issue of the residual flow and the longish connectivity is linked with the specific river morphology. Following Bratrich and Truffer (2001) the interrelationship between morphology and discharge plays an important role from the ecologic perspective of hydropower utilisations. In the best case residual flow dotation should simulate the natural hydrological regime (EC 1998: Chapter 5) including seasonal flow fluctuations where appropriate (LIHI 2005). This favours the species diversity (ESHA, 2004) and conserves locally adapted species and ecosystems.

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<sup>66</sup> WRG 1990



Furthermore residual flow dotation must assure that critical oxygen and chemical concentrations as well as temperature changes (bad for the fish and macro-zoo-benthos) is reduced. If those physical conditions change it will have an effect on the whole ecosystem. Water residence time in the original river bed stream is one of the most significant environmental variables that affect water quality and related problems such as anoxia(IEA, 2000: 28).

Animal populations (fish, MZB, benthic organisms) need also connectivity, as they will die out when the habitats are too small or too isolated. Fish passages must provide effective fish ways for anadromous<sup>67</sup> and catadromous<sup>68</sup> fish. Different distances of fish wandering exist. While fish species like salmon (anadromous) or eel (catadromous) change their salt and sweet water habitat and wander up to several 1000 km some species wander only in sweet water. Their distances range from several 100 km to 10-100 meters (Schmutz, 2005). A healthy fish environment has also a social relevance due to population eating the fish (see social relevance).

### **Sustaining morphological river conditions**

The typical morphological structure of the riverbed ensures individual river habitats as well as a connection with the surrounding systems like river bank and groundwater. If river sediments do not pass through the power plant, it will have an impact on (I) erosion or accumulation of sediments and (II) the composition of sediments. Both changes the original riverbed and habitat conditions. Accumulation and erosion often happen below storage dams and water intakes (Hütte, 2004).

### **Reduced impact on ecosystem**

Biodiversity entails three dimensions:

1. Diversity of habitats, fauna and flora e.g. for breeding, nesting, foraging, resting, over wintering, migration (IHA 2004). Special care must be taken for important or sensitive areas for reasons of their ecology, e.g. wetlands, watercourses or

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<sup>67</sup> Species who wander from salt to sweet water (upstream).

<sup>68</sup> Species who wander from sweet to salt water (downstream).

other water bodies, the coastal zone, mountains, forests or woodlands flood areas.

2. Diversity of species.
3. Diversity of genetic variability.

Operating rules of power plants are conceived in order to supply a specific energy service. However for a sustainable hydropower facility, these rules must also take into account impacts on fish and other species, as well as other needs and multiple uses of water such as irrigation, fishing, navigation, recreation, water supply IEA (2000: 34ff). Installation and power plant buildings of river plant types should be so designed that the connection between riparian zone and the main river channel is not disturbed => interconnection with residual flow and sediment management. Hydro facilities should guarantee habitat quality, protect animals against injury and death and qualitatively simulate the natural hydrological regime. In addition the cleanliness of the water stream has to be assured and critical oxygen and chemical concentrations prevented as well as the water temperature. The natural structure of the riparian zone is also important for the protection against flood events (German Federal Administration for Water and Geology, BWG, 2001). Passages with calm water lead to untypical choriotope (small ecologic spaces) conditions (Moog et al.1993). This will influence fish species as well as the macro-zoo-benthos (Moog et al. 1993).

Beside the fact that hydropower facilities influence ecosystems, several parts of the plant can lead to direct injury or the death of animals. Animals must be protected against injury and death stemming from plant operation and construction (turbines, canals, water intakes, ...). There should be no damage done to animal stocks and diversity of native fauna during construction work (Bratrich and Truffer, 2001).

### **6.3.2 Social criteria**

The overall social impact on the surrounding area should result in raising the well-being of the people. Criteria for well-being are very different among individuals. The only possibility to secure that a project promotes well-being consists of an ex ante implementation of personal values and wishes in a common decision-making process. The more underdeveloped the region and the more unemployed the people, the easier it

is to measure and gain an impact on the local economy (Schmidt, 2003) however defining predescribed indicators is a difficult task.

Several organisations like OECD, WB<sup>69</sup> have elaborated social sustainability indicators. Social indicators concerning hydropower constructions are measurable and quantifiable only on an individual consideration. This makes the comparability of different hydropower plants difficult. OECD and WB indicators are hence very general and in a qualitative manner, like creation of jobs, labour qualification, contribution of just resource allocation, gender equity, health, work insurance, support of social institutions, cultural support, decrease of poverty. Impacts concerning sustainability of a small scale hydro plant are seriously measurable on a local scale. Therefore the elected social criteria concentrate on the impact on local community.

Chapter 5.2 describes that public consultation does not function properly and has dubious impact in assessing the sustainability of a project. The essential point for a sound common decision-making consists of empowering local stakeholders in the decision-making process. The Gold Standard has modified regulations on public consultation (The Gold Standard 2003, 26ff). The modified consultation process is a step towards assuring common decision making. In addition it would be helpful if stakeholders are well informed on potential negative impacts of hydropower projects. Therefore several relevant criteria and indicators for social sustainability should be predefined and addressed in every stakeholder consultation. The results if the project succeeds have to be measured in an ex post monitoring.

### **Impact on local community**

A hydropower facility can influence the lifestyle of the local community directly or indirectly. The most problematic issue concerning social influences consists of displacement of individuals and communities<sup>70</sup>. This is however not usual in Small Scale facilities.

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<sup>69</sup> BMU is based on OECD and World Bank requirements.

<sup>70</sup> See also “The Gold Standard 2003: 34ff”.

The project impact on human capacity is a central criterion for social development (The Gold Standard 2003: 26ff) this means “empowerment and education of the people to participate actively in social and economic development”. The aspect of gender and the question if the project activity improves education/skills and livelihoods of women in the community is an other important issue (The Gold Standard 2003: 26ff). Further, human capacity comprises poverty alleviation (GS 2003: 26ff). In addition direct impacts are e.g. significant social changes to neighbouring village(s) or other stakeholders by changes of land use practice, irrigation, recreation, touristy<sup>71</sup> or traditional lifestyles. The GS (2003: 34) mentions possible impacts on sensitive uses e.g. places of worship, human heritage, community facilities, which could be affected by the project.

Other direct impacts like noise and vibration due to blasting, the power plant itself or due to construction and transportation (EC, 1998: 35). Furthermore transport routes or facilities on or around the location which are used by the public for access to recreation or other facilities might be susceptible to congestion (IHA, 2003). Furthermore changes in ecologic terms like changes to biodiversity in the area can have an effect on water quality which affects in a second step the surrounding people IHA (2003: 109).

### **Impact on public health**

IHA (2004: 18) warns that public health issues can result from the modification of hydrological systems, especially in tropical and sub-tropical areas where water-borne diseases can be a significant issue.

Construction safety comprises two relevant topics. Firstly it is important that the risk of accidents during construction or operation of the project is minimised. Especially in developing countries working conditions lack security and labourers have often no labour insurance. Secondly it is important that the facility is safe. IEA (2002) mentions that problems might result from earthquakes<sup>72</sup>, subsidence, landslides, erosion, flooding

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<sup>71</sup> Hydro facilities are often built in areas with special scenic or recreational value like waterfalls or step valleys.

<sup>72</sup> Large dams may adversely influence geologic stability and induce seismic activity. This has been observed at some of the largest reservoirs around the world. It is very difficult to predict such effects

or extreme or adverse climatic conditions. It is very difficult to predict those issues but by careful design and selection of building material of dams, possible damages can be mastered<sup>73</sup> (IEA, 2002).

Safety and health issues are discussed in OECD DAC guideline No 3<sup>74</sup>. The goal is to „avoid or minimize public health risks at the very onset of the project“. The aim is to gain a good understanding of current health conditions and strategies in the project area, for conserving or improving the health situation. For this purpose it might be necessary to provide a health specialist in the project design team (IHA 2003, from Energy policy, 2002).

### **6.3.3 Economic criteria**

The profitability or micro efficiency is the most important economic sustainability criterion. This is however calculated and “checked” by the project developer (Schmidt, 2003). Macro economic impacts of Small Scale projects like the net foreign currency savings resulting from a reduction of e.g. fossil fuel imports are possible to quantify (The Gold Standard 2003: 26ff). The GS lists an indicator aiming to assess the degree of technological transfer. “Hard currency expenditures on technology, their replicability” which contributes to technological self-reliance and shows together with the intensity of “technology changes between the host and foreign investors” a decrease of foreign currency investment. This indicator of technology transfer is often linked with SD and means the contribution to technological independence (BMU) and transfer of new technologies (UNEP). However technological transfer is not easy to measure and can not be answered in general terms. Hydropower research and development is done by a limited number of big international companies. For small countries it would be difficult to build up their own hydro companies. Even for big countries like India, building up new hydropower companies will be difficult. Foreign companies have settled their business in the country, e.g. Austrian VA Tech has a Turbine plant in

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(Vladut, 1993) but by careful design and selection of building material of dams, possible damages can be mastered. Geologic instability: Since such effects are not likely in Small Scale hydro power facilities and such most SC CDM projects are Run of the River facilities, we will leave it with that overview. Detailed information on the influence of dams can be found in European Commission: Small hydroelectric plants; Guide to the environmental approach and impact assessment.

<sup>73</sup> Mastered by e.g. a disaster management plans.

Bhopal and a transformer plant in Northern India. This means that technological transfer can only be investigated on an individual project basis.

Difficult to measure are two more indicators; the “increase of productivity and economic development as well as the indicator “incentive for inventions” (BMU, 2003). An investigation of enhancement planned facilities in Austria concludes that economic effects on other sectors like tourism, agriculture and forestry are hard to measure and must often be neglected (TIWAG, 2005).

Hence concerning SSC hydro plants those indicators are however hard to exactly quantify. Consequently only the economic effect on the local economy will be assessed in the SD assessment.

### **Impact on local economy**

The onset of a project in a given area represents a potential source of employment opportunities. IHA (2003) raises the issue of the “use of local and regional resource”. Those have to be “optimized so that local communities benefit from the project”<sup>75</sup>. The Gold Standard takes net employment generation as indicator of economic sustainability, measured by the number of additional jobs directly created by the CDM project (The Gold Standard 2003: 26ff).

Benefit sharing is a central economic sustainability issue. This means that communities and, or groups that are impacted by a project should be the first to benefit (World Bank 2001-2003<sup>76</sup>). At least a fair compensation of communities or individuals must be guaranteed. e.g. corresponding to a percentage of the power plant's income paid to regional and local institutions or the establishment of trust funds for environmental and economic development i.e. rural electrification (IHA, 2003). When the plant is operated with a high contribution from local manpower and resources, benefits are shared by creating new employment and encouragement of labour qualification (IHA, 2003).

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<sup>74</sup> The main issue in this guideline concerns resettlement.

<sup>75</sup> When the qualifications of local labour do not always correspond to proponents needs it may be advisable to provide technical training in such fields as environmental or social monitoring, natural resource management, etc. Further reading on IHA (2003).

Therefore it is helpful to “split construction contracts, in order to allow smaller regional companies to bid” and to encourage “large contractors to use local businesses to supply part of the services” IHA (2003).

Different economic interests of several stakeholders on the river water can be solved by designing and implementing a “river basin management plan that takes into account the water needs of concerned stakeholders” as recommended inter alia by IHA (2004).

### **Monitoring**

Following IEA (2000: 28) it is essential that an independent and regular supervision is performed, as monitoring represents an essential activity to ensure the application and effectiveness of mitigation measures. The organisation recommends that such programs are essential components of any hydroelectric project (IEA 2000: 28). A proper environmental follow-up program requires the collection of time-series of data both before and after the implementation of the project. Project monitoring should be periodically verified by carrying out environmental audits. Criteria are necessary to see if the project succeeded with the primary goal.

## **6.4 An operative criteria catalogue; indicators, quantification and costs**

This chapter proposes a criteria catalogue suitable for assessing the SD impact of Small Scale Run of the River and River CDM facilities. As mentioned above, the amount of criteria in the catalogue result of both the specific relevance and the cost-benefit ratio.

Defining indicators for criteria and the quantification is a difficult task<sup>77</sup> as sustainable hydropower is a new field where a lack of knowledge and best practice experiences exist (Hütte 2000: 7). This lack of knowledge is aggravated especially when it comes to the situation in tropical or sub-tropical regions. Therefore the measures should be rather seen as rough guidelines while indicators for social criteria are described in a qualitative manner. Social indicators need an ex post assessment or monitoring.

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<sup>76</sup> These groups should also participate in the identification, planning and distribution of benefits.

### 6.4.1 Sustainable planning

As seen in chapter 4.1 an early introduction of environmental and social concerns is essential for a sustainable project. Following Pelikan<sup>78</sup> (2005: 1) the engineer of the small hydro facility faces a “complete one-dimensional job, defined by the principle: design and implementation of a small hydro plant”. Pelikan (2005: 1) expresses the need of “embedding the one dimensional idea into a wider, comprehensive concept, receiving positive public interest. Conceptual approaches belong to engineering, but need also to be multidisciplinary and it is necessary to recognize sometimes complex links between them”.

Therefore a methodology for assuring sustainability of a hydropower project must be introduced during the size and technical planning of the scheme. Both, the social-environmental and technical issues of the hydro plant must be discussed with affected stakeholders. Only early negotiations of project alternatives and designs ensure a proper discussion as well as a fair decision (IEA 2000: 36). The development of short term as well as of long term community benefits must be a foremost project goal (IHA, 2003: 129). When the project developer has spent a large amount of money on planning he will not agree to talk about the “without” alternative. The community must view the process as being open, fair and inclusive, this means correct<sup>79</sup> representation of stakeholders who may be affected by the project (IHA, 2003: 129). Key issue is the common decision-making which means that all stakeholders come to the view that the project is the best alternative<sup>80</sup>. A process for addressing future concerns or risks from the project needs to be outlined to stakeholders at the start of the project.

For CDM hydropower facilities and their possible high negative impacts, the Gold Standard Stakeholder consultation requirements (see chapter 5.3.2) should be addressed (GS 2003: 37). The important second public consultation must be held after the final

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<sup>77</sup> Even the comparative decision making of already planned projects is difficult, as seen in Austrian investigations for hydropower facilities in Tyrol (TIWAG, 2005).

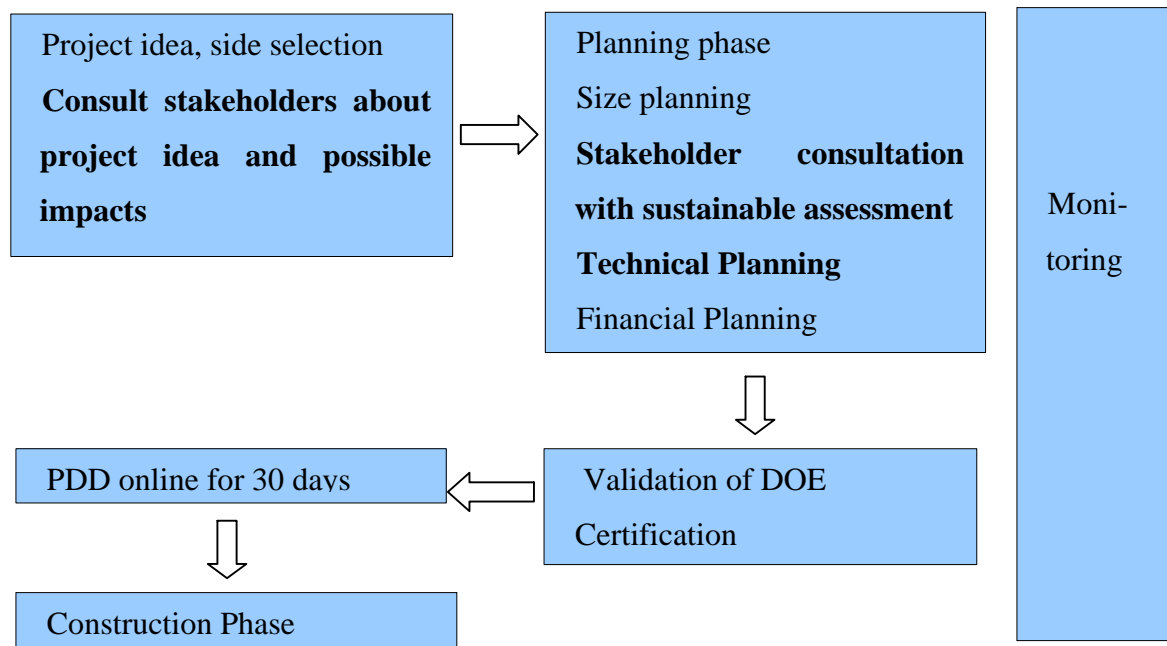
<sup>78</sup> The President of the European Small Hydro Association.

<sup>79</sup> Equity/ Gender consideration. Specifically identify any minority and / or vulnerable groups and ensure that they are adequately represented in any consultation process and are not adversely impacted by the project. (IHA, 2003: 130)



planning but before the construction work begins. Furthermore a sustainable planning process is essential for the positive correlation of sustainability and financial benefits (see chapter 3.4).

**Figure 6: Performance of sustainable CDM hydropower planning**



#### 6.4.2 Baseline/Reference assessment

Measuring the project's impact on Sustainable Development a reference or baseline is required for measuring and assessing ecologic, social and economic changes resulting from the project activity (Hütte 2000: 199). Defining a baseline it is necessary to draw borders of the system, which means the topologic, ecologic, social and economic borders<sup>81</sup>. Bratrich/Truffer (2001: 18) point out, that especially the type of hydropower utilisation determines the borders. It is further essential to record if the river is already affected by human use.

In a second step ecologic species and the morphological structure of the river will be collected (Jungwirth et al 2003: 371). Hütte (2000: 200) describes several possibilities

<sup>80</sup> Ensuring that the local knowledge of communities and stakeholders is utilised in project planning. Consultation with relevant local/regional, national agencies.

<sup>81</sup> The river itself (upstream and downstream), riverbed, shoreline, buffer zones (flood plains), additional neighbour habitats, effected stakeholders, economic effects...

for recording a baseline, recommending the “on location” methodology. Assessing the reference condition for fish ecology Jungwirth et al reconstruct historical data about the ecosystem (Jungwirth et al 2003: 371). Reference assessment should happen in the best case before beginning the construction. When the hydropower project is already built an upstream section of the river which is unaffected can be recorded as reference (Hütte 2000: 200ff).

**Table 7: Issues which have to be recorded for assessing the reference condition**

<b>Ecologic</b>	Inventory of character species (at least the biggest predator); abundance and age distribution.
	River morphology, the longish, vertical and horizontal connectivity of the river.
	Natural diversity, bank structure, buffer zones, temporary riverine habitats, woody debris.
	Species on red lists?
<b>Social/ Economic</b>	Water use as irrigation, drinking water, washing, recreation.
	Income that results of the river like fishing or tourist attractions.
	Social and economic circumstances of the region, income, electrification, employment, gender, amount of poor people.

### **Estimated Costs:**

Bratrich and Truffer (2001) recommend working with any morphological data that already exists. Field inspection of the catchment and one day fishing campaign to record the parameters for the fish ecosystem will however be necessary (ESHA 2004: 13). Consultation of local experts on the basis of existing environmental reports<sup>82</sup>.

### **Decision Making:**

The stakeholder consultation like prescribed by the CDM rules must be addressed before any decision is taken on the project realization. The negotiation results should be documented in a signed agreement as recommended by IHA (2003). The stakeholder consultation should scope the following points.

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<sup>82</sup> See therefore Bratrich and Truffer (2001).

Discuss the Sustainable Development criteria catalogue.

1. Discuss project alternatives, project modifications and compensation measures.  
Are there alternatives for the planned project? Discuss suitability of the project site, alternatives with local stakeholders and discuss also the without alternative.
2. Negotiations must result in a signed agreement with documentation of (I) stakeholder decisions (II) monitoring (III) compensation measures<sup>83</sup> and (IV) solutions for potential conflicts with water use.

### 6.4.3 Sustainability indicators, quantification, measures and costs

Chapter 6 has discussed the criteria for sustainable hydro. In this chapter the criteria will be indicators and measure will be defined and annotated for the operationalisation of the CDM criteria.

**Table 8: Summary of indicators and measures for the sustainability criteria**

Criterion		Indicators for the criterion	Measures
1	Three dimensional connectivity	Longish Connectivity	- Residual Flow Dotation - Riverbed Modification
		Horizontal Connectivity	
		Vertical Connectivity	
2	Sustaining river morphology	Bed load transport	- Operating rules - Sand trap flushing methodology - Power plant construction/design
		Riverbed conditions, degradation/accumulation	
3	Reduced impact on ecosystem	Ecologic sound living conditions	- Bio-engineering - Reduction of human impact - Minimum use of resources - Reforestation - Re-establish ecologic conditions after the construction
		Ecologic impact	
		Impact on Biodiversity	
4	Impact on local community	Human capacity, Gender and livelihood of the poor	Discuss indicators in the stakeholder process. Effected local community must be better off after the project's implementation than before.
		Interest conflicts with water use	
		Mitigation and compensation	
		Access to essential services	
5	Impact on public health	Disease vectors	- Investigate water related diseases - Security of labour - Security of infrastructure

<sup>83</sup> For example delivery of cheap power to neighbour village (if any). Further reading on IHA (2003).

		Infrastructure risk	
6	Impact on local economy	Impact on employment and economy in the local village/region	- Employment - Support economic structure of the region
		Allocation of financial benefits	- Discuss improvements for the local economy in the stakeholder process

### 6.4.3.1 Three dimensional connectivity

The residual flow<sup>84</sup> of a diversion type hydropower facility has to assure the three dimensional (longish, horizontal<sup>85</sup>, vertical<sup>86</sup>) connectivity of a river. This is the most important ecologic issue of a hydro plant. However for assuring the connectivity also the riverbed has to be for modified both for the connectivity and for providing ecologic conditions in the riverbed.

#### Residual Flow Dotation

The discussion about defined restwater formulas' changed by end of the 80s (Moog et al, 1993). Since then the residual flow is recommended to be calculated on an individual river basis<sup>87</sup> and not by general formula (Moog et al. 1993). However restwater formulas' can provide the first step for the calculation of the individual residual flow dotation. The individual treatment of specific flow dotations is important, thus every river has individual characteristics concerning

1. Abiotic conditions, temperature<sup>88</sup>, oxygenation<sup>89</sup>, seepage.
2. Morphology like riverbed structure<sup>90</sup>.
3. Biology, fish- non fish water, different species.

<sup>84</sup> Residual Flow: The amount of water which remains in the natural riverbed and creates no energy.

<sup>85</sup> River banks, flooding areas, including riparian vegetation

<sup>86</sup> Connection of ground and surface water

<sup>87</sup> For example in the revised Swiss Water conservation act (Bratrich and Truffer, 2001)

<sup>88</sup> Temperature should not increase or decrease more than 1, 5°C in Rithral and 3°C in Cyproniden waters.

<sup>89</sup> Oxygenation, especially important in rivers where waste water outlets discharge into the rivers or minimum flow (Bratrich and Truffer, 2001).

<sup>90</sup> E.g. connection with tributaries

#### 4. Human water use (Bratrich and Truffer, 2001).

In the case of sustainable CDM hydro simple measures like predefined formula facilitate to control and compare the different hydro plants. As the formula is still in use in numerous countries it should also be allowed in the CDM context. Taking a fixed amount of residual flow as ecologic measures for sustainable river has the advantage that this measure is simple for both, quantify and monitor. Measuring the dotation for the residual flow is done by a simple gauge.

Numerous residual flow formulas had been<sup>91</sup> developed. One of the most common formula for calculating the residual flow dotation is the Swiss Q<sub>300</sub> formula

$$\text{Restwater (R)} = 0,2 \times \text{Q}_{300}$$

It predicts power plants to discharge a minimum amount of 50l/s at all time<sup>92</sup>. This amount rises more or less linear depending on the discharge of the river. The maximum amount for water discharge contains 10 000 l/s.

#### **Riverbed Modification**

By finalising a hydro project riverbed modifications have to be performed, so that in the following the longish, horizontal and vertical connection of the river is established. This means interconnection with riparian and other water courses, ground water<sup>93</sup> as well as adjacent land (Bratrich and Truffer, 2001). The connecting biological links between riparian vegetation, aquatic, semi aquatic and terrestrial habitats<sup>94</sup> must be sustained.

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<sup>91</sup> Especially Switzerland has a long tradition on calculating residual flow formulas. The author recommends formula which determines the residual flow at different flow levels.

<sup>92</sup> Best with seasonal changes, see (Bratrich and Truffer, 2001: 36)

<sup>93</sup> Avoid any significant reduction in the replenishment of groundwater reserves, (Bratrich, Truffer, 2001: 38)

<sup>94</sup> Further reading in Bratrich and Truffer (2001)

1. Ensuring a certain width and depth variability of the residual flow for structural diversity like pools, riffles, pocket waters<sup>95</sup> => cross reference with residual flow.
2. Steps in the river should not exceed 20-30cm in Rhithral<sup>96</sup> and 10cm in Potamal waters<sup>97</sup>.
3. No removal of bed load

Estimated costs of the criterion longish connectivity. Remarkable financial losses result due to the fact, that the water which remains in the riverbed is not creating energy. This facilitated formula<sup>98</sup> can be taken to calculate<sup>99</sup> the costs for providing the reserved flow.

$$C = 40\,000 Q_r H T$$

C= annual costs,  $Q_r$ = residual Discharge or reserved flow (m<sup>3</sup>/s)

H= head (in meters), T= Tariff for the Power

### **Excuse; the rest water turbine**

Discussing financial losses resulting of residual flow dotation, one has to distinguish between the amount of residual flow (which is around 0.2%) and the amount of water which needs to be spend to the fish passage (0,01-0,05% of the total water). The water spent to the fish passage can not be used for hydropower purpose. However the amount of the residual flow less the water which is spent for the fish passage can be used. This rest water turbine does however not create so much energy, because the head fall is reduced. If it is proven that the facility is not in fish waters, all the residual flow can go through the restwater turbine.

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<sup>95</sup> As described in Bratrich and Truffer, 2001

<sup>96</sup> Upper section of the river, the potamal is the down section of the river.

<sup>97</sup> See Jungwirth/Pelikan (2005: 31)

<sup>98</sup> From: FAQ of small hydropower, (ESHA 2004) The whole formula consist of:

$$C = 0,001 e p Q_r g H T t ;$$

for C = annual Costs; e = efficiency, p = water density = 1000;  $Q_r$  = reserved flow (m<sup>3</sup>/s); g = gravity = 9,81 (m/s<sup>2</sup>); H = head (meters); T = Tariff (money/ kw/h); t = full load hours per year, usually 5000,

<sup>99</sup> "t = full load hours per year, usually 5000" is a comparable high number, Anne Schuster calculates with 4000 hours.

### **6.4.3.2 Sustaining morphological river conditions**

#### **Operating rules**

Operating rules must level (I) maximum financial outcome (II) good ecologic conditions for fish, MZB, algae, macrophytos and (III) social needs like uses of water such as drinking water, irrigation, fishing, recreation<sup>100</sup>. Those rules must take into account social considerations, both upstream and downstream of the project.

Bed load transport should happen on an ongoing basis to avoid marshy river flow sections or fine sediment deposits over a wide area => cross reference with residual flow. The quantity and quality of bed load has to be managed, so that the river system can develop a typical morphology<sup>101</sup>.

Riverbed and bank erosion as well as deposits of bed load have to be prevented. Tail water should be adequately step to allow bed load transport to take place. Bed load should get transported over the medium term, 1-5 years (Bratrich and Truffer 2001).

#### **Sand trap flushing**

The flushing methodology should avoid unnatural sand deposits and siltation in downstream river sections. Flushing should be performed in high water periods or with a long follow-up flushing<sup>102</sup>. Sand deposit should be flushed away within a reasonable period in ecologic terms, this means within a few hours<sup>103</sup> => cross reference with monitoring. Flushing should not allow temperature and O<sub>2</sub> concentration to reach critical levels => cross reference with residual flow dotation and monitoring.

#### **Power plant construction/design**

During the construction and after completion of the facility it is important to provide the ecologic basis for natural biodiversity of animal and plant species(Bratrich and Truffer 2001). Protection against animal injury.

1. Protect intake with a grid.

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<sup>100</sup> Please refer to IEA (2000: 34ff) for further reading.

<sup>101</sup> With relocation of channel patterns, bank erosion and deposition see therefore Bratrich and Truffer (2001).

<sup>102</sup> Further reading on Bratrich and Truffer (2001).

<sup>103</sup> Further reading on Bratrich and Truffer (2001).

2. Pen stock should not harm animal paths.
3. Cover or partly cover the penstock so that animals can pass (EC 1998: 26).

### **6.4.3.3 Reduced impact on ecosystem**

#### **Ecologic engineering**

1. Ecologic-engineering for shore protection and enhancement. Hard constructions should be built only in hydraulic strongly used parts of the riverbed (Bratrich and Truffer 2001).
2. Ensure a velocity in the head race channel of about 1 m/s (Bratrich and Truffer 2001).
3. Head race channel build in trapezium form and not steeper than 1: 2<sup>104</sup>. Planting of the head race channel, both over and under water.
4. Minimum tree cutting for construction and power line. Selective wood cutting<sup>105</sup>. Reforestation if trees had been cut<sup>106</sup>. Reforestation with local species Pelikan (2005: 21).
5. Tree planting at the original riverbed ensuring shadow and no critical temperature increase.
6. Use local building material, for both environmental and social reasons.

#### **Reduction of human impact on ecosystem**

1. Secure with a grid that no fish comes into the turbine. Protection of channel intake with a grid.
2. No accumulation of organic material (e.g. litter, mud).
3. Gravel removal and erosion should not take place => cross reference with monitoring.
4. Minimum noise, pollution.

#### **Minimum use of resources**

1. Minimum use of building material. Using of natural material where possible.

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<sup>104</sup> Pelikan lecture notes, EIA of SHP

<sup>105</sup> So that herbivorous mammals can find food.

<sup>106</sup> WRRL investigates also MZB, Algae/Periphon (key variable for water quality, high water and bed load dynamics) Further reading in European Commission (1998: 50)



2. Minimum truck and car movement<sup>107</sup>.

**Re-establish ecologic conditions after the construction**

1. Natural diversity of bank structure, buffer zones and temporary riverine habitats<sup>108</sup>.
2. Restore river banks, including riparian vegetation enhancement if damaged during construction<sup>109</sup>.

**Fish passages** can bridge highs up to 30 Meters by fish elevators. The amount of water needed for the fish passage depends on the type and size which itself depends on the size of river and the living fish species<sup>110</sup>. Values between 1% - 5% of the mean flow are rough numbers given by ESHA<sup>111</sup>. The best fish bypass is a natural structured bypass flow with the following requirements (Schmutz 2005).

**Table 9: Features of an optimal fish bypass**

	<b>Length of the pools (m)</b>	<b>Width of the pools (m)</b>	<b>Depths of the pools (m)</b>	<b>Max. Velocity (m/s)</b>	<b>Altitude difference between the pools (m)</b>
Epirhithral and Metahithral	1,5-3,0	1,0-1,5	0,5-1,0	1,8	0,3
Hyporhithral	> 4,0	2,0-3,0	1,0-1,5	1,5	0,2
Potamal	Several meters	Several meters	1,0-2,0	1,2	0,1

A fish passage must have a certain depth of water over the whole passage to ensure that fish can migrate unimpeded<sup>112</sup> => cross reference bed load budget. Costs of a fish bypass; ESHA gives the number between 1% and 10% of the total cost of the SHP (Bratrich and Truffer 2001).

<sup>107</sup> Further reading in LIHI (2005)

<sup>108</sup> LIHI gives extra three years of certification if there exists a buffer zone 200 feet above the high water mark

<sup>109</sup> Recommended inter alia by IHA 2003, referring on Energy Policy, 2002.

<sup>110</sup> The bigger the river the bigger amount of water is necessary

<sup>111</sup> If as recommended the amount of residual flow is individually investigated the fish bypass system water should be fixed after measuring flow velocities, turbulences, aeration... (ESHA, 2004)

### **6.2.3.4 Impact on local community**

#### **Human capacity, gender and livelihood of the poor**

Human capacity means the project's contribution to raise the capacity of local people and/or communities to participate actively in social and economic development (The Gold Standard 2003: 26ff). The sub-indicators concerning human capacity, gender and livelihood of the poor are directly taken from the "The Gold Standard PDD" and modified in some aspects. While the GS has defined adequate criteria the evaluation of the criteria lacks of performance. The criteria are not specific enough and no detailed measures are defined<sup>113</sup>. The sub indicators assessing social criteria must be addressed as direct as possible in the stakeholder process, like e.g. performed in LIHI (2005) certification. In the following the GS sub-indicators are modified towards precise questions which have to be addressed in the stakeholder process.

1. Does the project activity enhances and/or improves more widespread education and skills in the community?
2. Does the project activity enhance gender equality by improvement of empowerment, education/skills and livelihoods of women in the community?
3. Are less people living in poverty due to the project activity?
4. Does the project activity contribute to equal distribution of benefits and opportunities in particular marginal or excluded social groups<sup>114</sup>?
5. Does the project activity empower the access of local people to and their participation in community institutions and decision-making processes?

#### **Interest conflicts with the water use**

1. Has a joint agreement been finalised in the decision-making process?
2. Are operating rules taking into account impacts on fishing, drinking water, irrigation, recreation and other users of the water<sup>115</sup>?

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<sup>112</sup> Further reading inter alia on Bratrich and Truffer (2001)

<sup>113</sup> For example: Empowerment evaluates the project's contribution to improving the access of local people to and their participation in community institutions and decision-making processes. Education/skills assesses how the project activity enhances and/or requires improved and more widespread education and skills in the community.

## **Mitigation and compensation measures**

IEA suggests a regular revenue stream from the power plant operations which allows the implementation of regional infrastructure development and land-use planning initiatives, like watershed management or reforestation.

Social compensation:

A regional tax corresponding to a percentage of the power plant's income, establishment of trust funds for environmental and economic development, or an equity share of local institutions in the ownership of the power station.

Ecologic compensation:

When local losses cannot always be avoided, such impacts can be compensated on a river basin or regional scale, by protecting or managing similar habitats nearby<sup>116</sup>.

## **Access to essential services**

1. Is the access to essential services better than before the project<sup>117</sup>?
2. Is the access to affordable clean energy services improved<sup>118</sup>?
3. If resettlement is unavoidable. Are living conditions similar or better for the local population after resettlement<sup>119</sup>?
4. Is there an impact on sites with cultural and historical importance? Is the impact minimised and do stakeholders agree on the solution<sup>120</sup>?
5. Does the facility allow to the local population to use the river as for recreational activities<sup>121</sup>?
6. Will the project cause noise and vibration?

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<sup>114</sup> This indicator combines quantitative - changes in estimated earned income (normalised to the project's starting year) compared with the baseline – and qualitative assessment - improved opportunities.

<sup>115</sup> Further reading in IEA (2000: 28)

<sup>116</sup> Further reading on IEA (2000)

<sup>117</sup> This indicator of social sustainability is measured by the number of additional people gaining access of (water, health, education, access to facilities, etc.) in comparison with the baseline. Access must be directly related to the service and not an unintended impact.

<sup>118</sup> Measured with the coverage of reliable and affordable clean energy services, especially to the poor and in rural areas.

<sup>119</sup> For example the World Bank's Resettlement policy should be implemented.

<sup>120</sup> This has to be discussed in the stakeholder process further reading in LIHI (2005)

<sup>121</sup> See therefore LIHI (2005)

7. Is access to recreation or other facilities susceptible to congestion<sup>122</sup>?

Total costs of measurements to mitigate the negative impacts on the local community are not possible to quantify. The compensation and mitigation measures depend on the negotiation power of the local community.

### **6.2.3.5 Public health**

#### **Disease vectors**

Potential, water related diseases like malaria have to be addressed. If water related diseases occur, they have to be published and mitigated by a good project planning and or mechanical/ chemical treatment IHA (2003, referring on Energy Policy, 2002).

#### **Infrastructure Risk**

1. Have measures been undertaken to secure the security of the employees and hired labour, concerning working conditions?
2. Construction safety, e.g. if the facility has a dam. Has a dam safety plan been set up? Issues concerning dam safety is handled in World Bank operational policy (2001-2003) and IHA (2003).

### **6.2.3.6 Impact on local economy**

#### **Employment**

1. The amount of labour created by the project. Here it is not possible to give an overall figure.
2. How is the quality of the employment, such as whether the jobs resulting from the project activity are highly or poorly qualified, temporary or permanent (GS 2003: 26).

#### **Support economic structure of the region**

1. Preferential hire of local workers.
2. Preferential use local specialists.
3. Preferential use local material (Gold Standard, 2003: 27).

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<sup>122</sup> Transport routes or facilities on or around the location which are used by the public might be

### **Discuss improvements for the local economy in the stakeholder process**

1. Are jobs affected or endangered by the project?
2. Are groups negatively affected by the project? E.g. groups which use the river like fishing (downstream or upstream riverside population), irrigation, agriculture, drinking water, tourist income (IHA 2003: 121).

### **6.4.4 Monitoring**

The effectiveness of many measures is well known. However some may require a specific follow-up program. This is particularly the case for experimental measures for which there is little or no experience available from other projects (IEA 2000: 28). Measures e.g. compensation often depends upon regional and national policies and programs which come under the responsibility of government agencies. Following IEA (2000: 28) it is consequently important that project proponents must cooperate with such agencies in order to assess potential impacts and design appropriate mitigation, enhancement and compensation measures. The criteria catalogue recommends to monitor the following aspects.

### **Stakeholder process**

1. Had the stakeholder process been in an open and fair atmosphere?
2. Had a sustainability catalogue been discussed in the process?
3. Has a signed agreement been established on stakeholder decisions, monitoring, compensation measures and solutions for potential conflicts with water use?

### **Key ecologic and social indicators, mostly derived from EU/TUCN (2000: 20)**

Ecologic indicators:

1. Monitoring of the well being of at least one “control” fish species (character species or biggest predator) for toxicological, temperature and O<sub>2</sub> supervision” (Jungwirth (2004: 45)?
2. Investigation of habitat conditions and diversity.

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influenced by traffic resulting out of the project.

3. Investigation of the impact on exotic species and species on red lists<sup>123</sup> (if any).
4. Monitoring of the condition of the vegetation, bank structure, shoreline buffer zones and flood plains. Riverbed degradation, erosion or accumulation?
5. Residual flow duration, depth and condition of residual flow.

Social indicators:

1. Changes in land-use, particularly the extent of land cultivated?
2. Changes to the primarily assumed effects on local people after the project had been established?
3. Accumulation of solid waste?
4. Occurrence of water transmitted/related diseases in the community?

**Mitigation and compensation measures**

1. Have measures been fulfilled as written in the signed agreement?
2. Had the compensation measures been performed?

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<sup>123</sup> The IUCN red list.

## 7. Field study in India, June 2005

The author conducted a field study with the purpose to visit CDM hydropower facilities in India (May/June 2005). During this visit the methodology, criteria and indicators had been tested and important information e.g. the availability of assessment indicators had been gathered and implemented in the final version of the catalogue.

### Introduction

With 903,8 Mio. metric tons (1999 Earthtrend) India is the 5th biggest emitter of Greenhouse gases. The GHG emissions have grown by 40% between 1986-1995 (Chopra, 2004). Following USAID (2005) electric power generation is the largest emitting source of GHG in India. India's total installed capacity is around 112.058 MW (March 2004) excluding small hydro, biomass and wind sources (Chopra 2004). The energy<sup>124</sup> is produced by: 71% thermal, 25% hydro, 3% nuclear and 1% wind generation (Chopra 2004).

The energy demand in India is huge, growing by 5% yearly<sup>125</sup> (Chopra, 2004: 235). Chopra projects an energy grow by 300% in the time from 1980-2010 (Chopra, 2004). Following Chopra coal will still play a major role in the future energy supply but renewable power is becoming competitive, referring on the Indian ministry for non conventional energies which proposes that 6% of the total installed capacity until 2012 will be from renewable energy sources. Until 1991 the energy sector had been totally controlled by the state, while now public participation is possible (Chopra, 2004).

### Hydropower in India

In India more than 85% of the possible water resources are used by the agricultural sector (Zingel et al, 2003). In comparison with other alternative energies like wind or solar power, hydro has a long tradition. The first station was built 1897 by British engineers in Sindrapong, West Bengal.

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<sup>124</sup> March 2002

<sup>125</sup> Other sources talk of 8% yearly.

Following Chopra (2004) hydropower remained vastly untapped in India until a recent initiative by the Prime Minister which aims to accelerate the development of hydropower and install the capacity of 50,000 MW in the next years. Although hydropower is vastly untapped in India, several authors like Ajunthadi Roy claim already negative impacts of hydro projects. Since the Indian independence more than 35 million people had been displaced due to big hydro dams with often bad rehabilitation (Roy, 2004). Initiatives against hydropower facilities claim the lack of environmental and social issues in the project planning<sup>126</sup> (Roy, 2004). After the WCD report in 2000, World Bank and other ODA organisations refused financing hydropower projects in India (DIW/HWWA 2004: 9). This policy changed in the last years and the new country assistance strategy (CAS) of the World Bank deals with US\$ 550 Mio for new dams (IRN 2004:2). In August 2004 several Indian and international NGO's have rejected the CAS. They claim lack of transparency and the inability to learn from earlier WB project problems.

According the information of the Ministry of Non-conventional Energy Sources ([envfor](#)) the total installed capacity of small hydroelectric projects is 1944 MW, including projects under construction (Chopra 2004). The estimated potential of small hydropower is at 10 000 MW<sup>127</sup> (Chopra 2004). Hydro plants in India are more personal intensive in comparison to developed countries.

Following IRN (2004:7) India uses own EIA requirements and refuses WCD guidelines for projects less than 25 MW. As per the Ministry of Environment and Forests, EIAs' for small hydroelectric projects are not required when investments are less than US\$ 21.74 millions (Dehar PDD 2005: 29). This will be the case of most Small Scale hydropower facilities e.g. the Dehar CDM hydro project is a 5 MW project with investment costs of US\$ 5.4 Mio (Dehar PDD, 2005: 29).

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<sup>126</sup> Dealing with hydropower most project developers and planners don't consider those issues. Chopra claims various limitations of hydro power development, however he lists no ecologic or social limitations (Chopra, 2004: 282)

<sup>127</sup> Compared to wind power: 450 000 MW



## **India, Kyoto and the CDM**

Jacobsen<sup>128</sup> (1998) describes that India shows moderate interest in combating climate change and bringing the Kyoto protocol forward, pointing out the little per capita CO<sub>2</sub> emissions of approximately one fifth the world average<sup>129</sup>. The country acceded the Kyoto protocol in August 2002. At Carbon Expo 2005 the Indian DNA claimed to provide best circumstances for CDM projects, not only due to good investment climate and developed status of the country, but also due to the developed democracy and civil society which guarantees that the project cycle runs in a fair and open atmosphere (Mr. Sethi, head of DNA<sup>130</sup>). Following Chopra (2004: 246) investigations by the IIM, Ahamadabad estimates the potential of CO<sub>2</sub> reductions to 5000 Mio Tons in the 2008-2012 commitment period.

India is the biggest CDM country, contributing with more than 30% to the total number of registered CDM projects (UNFCCC statistics). India has 12 registered hydro projects (UNFCCC Homepage, 19.6.2006). Small Scale hydropower is not common practice in India, thus only very few private financed Small Scale projects have been realized (Dehar PDD, 2005). Small hydropower projects mostly argue to be additional due to financial additionality. Concerning the proof of financial additionality the author had the impression that proving the additionality of hydro power facilities is not too difficult<sup>131</sup>.

Aiming to assure the contribution to SD the Indian DNA has developed a document for host country approval called PCN<sup>132</sup>. Projects have to fulfil 42 CDM criteria. Seven criteria handle possible environmental and social impacts. Those are however rather general. The Indian DNA is convinced that the national and state hydropower laws, together with the stakeholder process, „local people are the best to judge“ assure the projects contribution to SD (Mr. Sethi pers. comm.). The Indian DNA is convinced that

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<sup>128</sup> In Zingel et al, 2003 „... India is left merely to respond to the agendas on climatic change of politicians, researchers and industrial interests of the North“

<sup>129</sup> Results in 1.1 tons (1996) compared to China 3.7 or Germany 11.0 tons (Zingel et al, 2003)

<sup>130</sup> During the field study in India the author had the opportunity to interview Mr. Sethi, Head of Indian DNA.

<sup>131</sup> Not only projects with too low IRR claim financial additionality also projects which with IRR higher than 15% (pers. communication Mr. Sethi).

<sup>132</sup> Download under: [http://envfor.nic.in/cdm/host\\_pcn\\_format.htm](http://envfor.nic.in/cdm/host_pcn_format.htm)

more specified sustainability criteria than found in the PCN would not better judge if hydropower projects contribute to Sustainable Development.

Following Sethi the DNA does not conduct EIA on project side. This is done by the responsible DOE. The Indian NGO “Down to Earth” investigated the approval procedure of the national DNA (Down to Earth, 2005);

*“according to its member secretary R K Sethi, it meets once a month to clear anything between 10-40 projects: the project proponents submit the project design documents and make a short presentation, which are then reviewed by representatives from different ministries”.*

When Down To Earth (2005) contacted Sethi he clarified project rejection was usually not the norm in such meetings. As shown later it is not easy to check if a project contributes to Sustainable Development on a short desktop study.

## **7.1 Himachal Pradesh**

The Dehar CDM project claims that “as on date (June, 2005) only two comparable hydroelectric plants are commissioned in the Himachal Pradesh State, the proposed project activity is the second of those already commissioned in Himachal Pradesh” (Dehar PDD: 15). Following the PDD (Dehar PDD: 33), the Government of Himachal Pradesh (GoHP) follows a, “stringent public consultation process for new projects in the state of Himachal Pradesh. Before issuing license for any new project, GoHP announces the proposed project scheme in the local press and invites for any objections / comments from the public. Period of public announcement will be 90 days. After reviewing the public comments if any, GoHP decides on whether the project to be sanctioned or with held. Similarly, Electricity Regulatory Commission of Himachal Pradesh (ERCHP) also makes a public announcement in the local press in local language for public comments on the project ... Announcement will be kept open for a period of 60 days. ERCHP considers public comments in its approval process before giving approval. Apart from the above, as per the GoHP guidelines, the project proponents shall be required to obtain No-Objection Certificate from the Village

Panchayat, an elected statutory body of the local populace where the project is proposed. Hence, any new electricity generation project proposed in the state of Himachal Pradesh shall pass through the above three public consultation processes. Until and unless they are cleared in the process, project proponents cannot proceed further with the implementation”.

Personal experiences in Himachal Pradesh lead the author to doubt the good performance of this procedure. During visiting the Maujhi CDM project (finished in 2004, registered in November 2005) the local people claimed that no stakeholder process was held (pers. comm. villagers). The project is government owned. CDM-India in Delhi confirmed the lack of stakeholder consultations and claimed that the project had been planned before the new law was launched<sup>133</sup>. Concerning the CDM registration this is a severe violation.

#### **7.1.1 Fozal hydropower scheme**

Fozal is one of the tributaries of the Beas river in the Kullu Valley. The Beas river is used extensively for hydropower generation. In the Kullu valley numerous hydropower plants exist and new ones are in the planning process. The Beas river is already widely affected by human use as about 100 km further downstream of the described project a big hydro project dams the whole river<sup>134</sup>.

The planned Fozal hydropower facility is considered as a diversion section Run of the River project. The project will be placed at the very down section of the Fozal valley, with the intake about 4 km before the Fozal stream flows into the Beas river. The Fozal valley stretches about 100 km into the mountains. In the valley extensive farming is taking place and ecotourism is planned (Project PDD). The author stayed one and a half days investigating the project and talking to the local engineer Mr. Verma.

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<sup>133</sup> This however raises concerns about the additionality of the project.

<sup>134</sup> Assuming without residual flow dotation or fauna friendly construction.

### **7.1.1.1 Sustainability Assessment**

No initial baseline or reference assessment had been performed and no information could be gained on sensitive habitats and species. In addition no reference assessment on the socio economic situation could be taken into account.

#### **Three dimensional connectivity**

A reserved flow is planned for the hydropower facility. However Mr. Verma the technical advisor could not give information about the amount for the restwater. Information about planned modifications in the riverbed aiming to improve the ecologic conditions could not be gathered.

#### **Sustaining river morphology**

As this hydropower scheme will be a Run of the River scheme flushing is only necessary due to sand trap flushing. Sand trap flushing will be done continuously with the help of a small tributary of the Fozal River. The author was not able to investigate the issues if the facility will be constructed in an ecologic way as there were no information about building materials as well as exact design information of the plant.

#### **Reduced impact on ecosystem**

The indicator of “the impact on the ecosystem” could not be measured thus (I) the facility was in the planning phase and (II) no detailed technical study of the facility has been conducted by the author. A very positive issue concerning a minimum impact on the ecosystem is the plan not to build a road to the dam site of the project, but to transport all necessary goods by human and animal power<sup>135</sup>. Issues about bio-engineering could not be investigated. Following the technical advisor, problems with fish population do not exist (see fish passage). The influence of the pen stock had not been discussed in the field.

In addition almost no trees will have to be cut off for Fozal scheme because the power line connection is very close to the power house (about 500m). The issue about minimum truck and car movement could not be assessed by the author.

Fish Passage; following Mr. Verma there are no or only very few fish in the Bea and Fozal stream and no species of bigger fish can be found. Verma has sent in a report on “non negative impacts” on fish populations to the regional administration of the Manali District. However this point seems not investigated deeply enough, thus no study on fish populations was provided. An FAO study (FAO 1995) of the reservoirs in Himachal Pradesh shows diverse fish species and fish production in the reservoirs of the Sutlej and Beas. The wandering of the fish species, as well as the nutrition and bed load management will be influenced by hydro projects.

### **Impact on local community**

The author gained no information about stakeholder consultation. The following issues about the impacts on the local community have been discussed with the local engineer. Besides jobs, no further positive impact on human capacity, gender and livelihood of the poor can be found.

Interest conflicts with the water use exists, as the local community has irrigation systems in the section below the diversion channel (Mrs Pamposh Bhat, CDM India, pers. comm.). Since Fozal is a small hydropower facility the impact on recreation sites is minimised. The affected section, the natural river bed which is left with very little water stretches only about 4 km. However the fish are an important social issue, thus the Kullu valley thinks about developing eco tourism and trout fishing might be promoted like in the tourist town of Manali.

Concerning transport routes; the Manali valley is a very busy region<sup>136</sup> with only one major road which is often congested. The project will lead to additional traffic, which will affect the local community. Noise and vibration is caused by blasting for the diversion channel.

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<sup>135</sup> However this might be a pure economic reason and not a social idea.

<sup>136</sup> With touristy and agricultural industry as well as important traffic routes likes Rohtang pass to Kashmir.

### **Impact on Public health**

Disease vectors like malaria are not likely to occur, since Fozal is in the chilly Himachal Pradesh district. Beside no dangerous impact of the Fozal construction for the local population can be stated. Risks of the infrastructure risk can only hit workers during the construction.

### **Impact on local economy**

For the construction it is planned to hire about 1000 workers<sup>137</sup>. Following the PDD most workers will not come from the region due to “lack of labour in the Fozal valley”. Hence a positive impact on the local economy by creating income due to labour can’t be stated. After finishing the work it is planned to create 50 permanent jobs which might give permanent labour to some of the villagers. In total no jobs will be endangered.

Other benefits for the local population were not shown to the author.

### **Monitoring**

Following the PDD no monitoring measures are planned.

#### **7.1.1.2 Does Fozal contribute to Sustainable Development?**

The project is built in an area which is already widely used for hydropower. Concerning SD this can mean either, that it is important to save the last undisturbed rivers in the region or that the impact on the environment is not so heavy due to the fact that the ecosystem is already effected.

A positive aspect of the project is the fact that it is a run of the river project and that a high number of workers both in the construction and running phase of the project is employed. This high number of workers results also, because no road should be built to the construction which can also be assessed very positive. In addition the continuous sand trap flushing can be credited positive.

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<sup>137</sup> This high number of workers is also because no road should be build to the construction.

Negative aspects are the lack of the initial investigation of the projects impact on the ecologic condition. This is an important work in regions which are already influenced by human impacts and where additional projects are planned. Furthermore it is important to clear the interest conflicts with the stakeholders on irrigation and potential tourist sites. The author had no possibility to talk to stakeholders of the surrounding villages. However as mentioned above concerning different interests of the water use conflicts seem exist. Compensation measures should also be discussed with the local community as they feel no large benefits resulting out of the project (few jobs, no capacity building, and no additional measures concerning SD).

It can be concluded that specific sustainability issues are not taken into account. Several issues have to be assessed in more details. When the negative aspects are cleared the project can proof to contribute to Sustainable Development in the Fozal/Manali region and India.

Hence the authors judgment is, that the project is marginally contributing to SD, however it would be easily possible to have a larger positive impact.

### **7.1.2 Maujhi hydropower facility**

Maujhi is a 4.5 MW diversion type project, situated close to the village of Kanyara which is about 20 km away from Dharamsala. This Run of the River hydropower project is the first in the creek. The author had no guidance visiting the project but he had the opportunity to visit the construction with a local villager and talk to technical employees.

#### **7.1.2.1 Sustainability Assessment**

No baseline or reference assessment was available and could be taken into account.

#### **Three dimensional connectivity**

A residual flow remains in the stream but the author had no possibility to measure the amount. It seems to be unlikely that the dotation of residual flow had been calculated on a basis suitable for the river connectivity thus no gauge or channel is installed for the restwater. The riverbed had not been modified for better ecologic conditions.

### **Sustaining river morphology**

The flushing of the sand trap is not happen continuously and effecting the flow of sediments and the flushing effects the ecosystem.

### **Reduced impact on ecosystem**

The intake of the channel is protected by a grid. However in high water periods smaller fish might get flushed over the grid and get stranded. The penstock is only covered in the upper section, where the street crosses. While the penstock is in a very steep terrain animal paths seem not to be disturbed. The area of the hydropower facility not densely populated by trees and no or minimal trees needed to be cut for the construction.

Fish Passage; the facility has no fish passage, but thus the river is in a very hilly area and bigger natural steps occur naturally downstream of the diversion section, one can assume that no bigger fish or wandering fish species are in the upper part of the river.

### **Impact on local community**

The project creates about 50 new jobs. How much the income and the project contributes to human capacity could not be investigated. Further the author could not gain information about project alternatives, mitigation or compensation measures.

During the diversion section no other use of the water resources exists. Finally there should be no conflicts on water use and problems with different stakeholders. In the section of the hydropower facility there are no recreation facilities which are used by other stakeholders, since there are no direct neighbour villages to the project side. However the street leading to the facility can be used by the local people reaching the river or the upper valley.

### **Public health**

Since Maujhi is in the chilly Himachal Pradesh district no problem with disease vectors, like malaria should occur. No dangerous impact of the Mauhij construction for the local population can be stated. Also here infrastructure risks can only hit workers during the construction.



### **Impact on local economy**

Permanently the project provides 50 jobs at the hydro station. More than 1000 people were working for a short period during the construction (pers. comm. project engineer). No stakeholder process had been performed consequently it is unlikely that an allocation of financial benefits had been discussed.

### **Monitoring**

No data about monitoring could be gained.

### **7.2.2.2 Does Maujhi contribute to Sustainable Development?**

Like Fozal, the Maujhi project is build in an area which is relatively good developed by electrification, infrastructure and labour. The project does not create new electrification and the power created by the new facility will be spend in the local grid and most likely exported to the lowlands. Also in the Mauhij project the positive aspect of the project is a high number of workers both in the construction and running phase of the project. While it is unclear from where the workers for the construction of the plant com, the non skilled permanent workers seem to be from the local village of Kanyara.

The natural potential of the site contributes that the project does most likely affect the ecology less than e.g the Fozal plant. This results due to the steeper terrain and less trees and shorter head race channel. Furthermore no other interests on the river are claimed. The irrigation channels begin about 100 meters after the power plant. The natural potential of the site contributes that the project effects the ecology less than the Fozal plant. This results due to the steeper terrain, less trees and shorter head race channel. Furthermore no other interests on the river are claimed. Irrigation channels begin about 100 meters after the power plant. Concerning the horizontal and vertical connectivity the step terrain helps that the connection to the original riverbed remains. However the residual flow does not assure the structural river diversity.

While the project has no specific ecologic design, it would be easily possible to build the facility in a more ecologic way. Namely rising the amount of restwater and reforestation measures can be performed in a cheap way. The reforestation would

furthermore protect the power plant building from possible landslides of the steep terrain above the buildings.

Although the project seems to be appreciated by the local population the stakeholder process and the decision methodology severely lacks of performance. The PDD (2005: 30) claims that: “The project proponents ...had involved all the stakeholders for setting up the 4.5 MW Maujhi small hydroelectric project and had extensive discussions with the above stakeholders well in advance before implementing the project. According to the GoHP requirements ... the project passed through the public consultation process before the starting the implementation. The local population welcomed the project due to benefits like development of infrastructure in the area and additional sources of income during construction, employment etc. No comments were received and the project obtained approval. Village Panchayat issued NOC for the project activity.”

Following the local villagers no stakeholder process was held, whether during the planning nor the implementation phase (pers. comm. villagers). This statement could be confirmed by Mrs. Pamposh Bhat from CDM-India.

Consequently the highest concerns about this project occur due to the missing stakeholder consultation process in the village. This is a severe lack and the CDM is not made to support such projects. Improving those negative impact one can state that the project contributes to Sustainable Development in the region.

## **7.2 Karnataka**

The state of Karnataka has vast potential for the development of small hydropower projects; 801.1 MW (PDD Mahatma Gandhi project). Out of this potential only 180 MW<sup>138</sup> has been commissioned thereby only 34.2 MW is developed through private parties and 25 MW by the state government (Chunchi Doddi PDD).

In Karnataka irrigation projects range first, secondly hydropower projects. The project developer introduces the project to the state government and lists land requirements of private and government land. If the state government accepts the project, the administration of the state handles the appropriation and compensation.

### **7.2.1 Chunchi Doddi hydropower facility**

The Chunchi Doddi hydropower facility is situated about 80 km south-west of Bangalore. The stream carries mostly Bangalore sewage water. The region is relatively well developed with having electrification is mostly all houses. the project does not lead directly to new electrification. It is planned to harvest water energy during the rainy season, for about three month. This seasonal restriction results, because a big irrigation dam further upstream uses also the water and spends large amounts of additional water only in the rainy season. Following the project developer, the amount of water which remains in the stream in the dry season is too low for running turbines. The approximate head is 100 Meters.

#### **7.2.1.1 Sustainability assessment**

No information about a baseline reference assessment could be gained. A “rapid EIA” had been performed (see excursion, Experiences with EIA in India), however this work had been done after project implementation and in a rather non scientific way.

#### **Three dimensional connectivity**

During the whole year little amount of water remains in the river. However one can state that the connectivity of the river is already widely affected due to the big

irrigation dam upward. The author could not gain information about the amount of residual flow or planned riverbed modifications. This topic was not handled in the EIA.

### **Sustaining river morphology**

Concerning operating rules information lacks to assess them properly. During the monsoon time where enough water is in the river, the facility creates energy. It is not clear if a residual flow is assured at operation time.

### **Reduced impact on ecosystem**

The ecosystem is already affected by

1. The irrigation dam which is situated some kilometres above
2. The fact that Bangalore sewage water is in the river.

The penstock is embedded due to temperature levelling, helping animals to pass. Trees had been cut off and no trees had been yet reforested, as promised in the PDD. Following the PDD the planting is planned in October 2005, which means a delay and likely erosion during the monsoon.

Fish Passage; no fish passage is built, but fish wandering is not possible due to the natural waterfall and the big reservoir which is about 5 km upstream of the project.

### **Impact on local community**

The government ruled the compensation of land of the facility. It could not been investigated if the farmers are satisfied with the compensation. Fishing in the river is possible and the project is not effecting fish population. Transport routes are not susceptible to congestion, thus the area of the project is not broadly used. Noise and vibration occurs due to blasting, but no village or house is around the project, so no person will be disturbed.

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<sup>138</sup> Central Electricity Authority, Energy generation, program and plant load factor: an overview, March 2004

### **Public Health**

Disease vectors might exist and should be investigated. However it is unlikely that the project aggravates possible diseases, thus not many areas of shallow and slow water exist.

### **Impact on local economy**

The project employs five engineers and about 20 additional permanent jobs. 500 jobs during 3 month of first construction period had been created, however it is not clear from where the labour had been hired.

### **Monitoring**

No monitoring could be observed or is listed in the EIA.

#### **7.2.1.2 Does Chunchi Doddi contribute to Sustainable Development?**

Due to the fact that the river is already widely affected by the human use; sewage water, irrigation dam, one can conclude that the new facility will not have a severe negative impacts on the local ecology.

However the project does not use the chance, beside creating renewable energy, to improve the sustainability of the project and the ecologic and social development of the region. E.g. the head race channel is not planted and the sides are very steep, which under an ecologic viewpoint could have been improved. Reforestation measures had not been performed and further ecologic or social measures which could increase the Sustainable Development are not planned. Consequently the Chunchi Doddi project can be seen as a sustainable project but contributes only due to the creation of new jobs to the regional Sustainable Development. Due to the fact that the river is already widely affected and the project uses only the additional water from the dam this project has a sustainable concept.

## **Excuse, experiences with EIA in India**

The Himachal Pradesh state in India does not require an EIA until a certain investment amount. From the three projects that had been visited only one EIA had been performed, the Chunchi Doddi. The project manager Mr. Singh and the project developing association is familiar with sustainability issues and had planned the project with best sustainability intentions.

However the manner how the EIA had been performed leaves the author with the opinion that the research team (Centre for Symbiosis of Technology, Environment and Management, Bangalore) was not familiar with environmental impacts and problems of Small hydro schemes. E.g. the aquatic ecology and the river continuum is handled in the following way (EIA Chunchi Doddi: 30): „During the operational phase of the project, the entire quantum of water utilised for running the turbines will be released back into the river within a distance of about 2km along the river course. Thus, there will be no impact on the flow pattern of the river downstream. Hence, there will not be any impact on the aquatic flora and especially fishes.“

Key investigations which discuss potential negative impacts on fish species, bedload management, and the situation of the river ecology were missing. Instead the study concentrated on topics not relevant under an ecologic viewpoint concerning a hydro plant: technical details of the plant (4 pages), air quality of the location (4 pages), wind roses of Bangalore<sup>139</sup> (2 pages), general demographical changes of the project surrounding villages (6 pages).

Compensation measures were defined as the following; the “project developer commits to implement the proposed EMP in its true spirit”, however the commitments “to stabilise all disturbed slopes before the onset of monsoon to avoid soil erosion“ was violated. Until June 2005 no tree was planted, the project engineer assured to start the tree planting program in October (after the Monsoon) due to best planting conditions.

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<sup>139</sup> Bangalore is more than 80 km away from the hydro site

In this context it is important to think about punishments for violating environmental and social promises. Violating promises and compensation measures is also a problem for certification companies (pers. com. Carbon Expo, Cologne 2005).

### **7.3 Desktop PDD study**

During a PDD desktop investigation of CDM hydro projects concerning their SD impact, the author made the experience that a serious assessment is not possible. The information provided in the PDD is not enough and sometimes not clear to get an image of the impact on Sustainable Development. The following chapter points out different sustainability issues which are not handled detailed enough in the PDDs’.

#### **7.3.1 Dehar 5 MW, Himachal Pradesh**

This project was registered the 18. July 2005, being the first registered CDM hydropower project in India. Dehar is a 5 MW project in Himachal Pradesh (Dehar PDD: 29). Concerning the additionality the PDD analyses barriers. Those barriers are however more or less normal hydro project risks, like planning problems, uncertainty, and barriers with the construction or hydrology. These barriers are not barriers in the sense of the CDM.

#### **Sustainability Assessment**

The PDD claims minimum impact on the environment. This is a representative statement for many hydro PDDs’, “disturbance in the local eco systems, deforestation etc. are not involved. Hence, in conclusion, the project does not cause any impacts on the environment...further, the project does not result in to degradation of any natural resources, health standards, etc. at the project area. Hence, the project contributes to the environmental well being“.

A five MW project which is, like in the case of Dehar the first project in the river has however undoubtedly an influence on the local eco system (bed load, fish species, connectivity of rivers, erosion, and disturbance of the ecosystem). The above stated argument are supported with EIA results. The PDD writes that the EIA “can be seen on request”. During the online comment period of the project, the author requested the

EIA (August 2005 by email). Unfortunately the project developer did not send an answer.

The PDD gives the number of 5.40 million US\$ investments in the area,“ which otherwise would not have happened in the absence of the project. This is a very significant investment in an underdeveloped area“. However the area does not benefit of the total investment costs of US\$ 5.4 Mio. Only investments like wages (US\$ 97,826) or infrastructure investments contribute directly to local capacity.

“The project is implemented in a rural area, which is not having proper roads and other infrastructure facilities. project proponents had constructed roads and other infrastructure facilities in the village as a part of the project construction“. Infrastructure construction from which people can benefit might harm in the other way the ecosystem and can lead to secondary environmental problems like soil erosion, noise, problems for wildlife. This is not “per se” a positive impact on SD.

### **7.3.2 Mahatma Gandhi Dam 22MW, Karnataka**

This project uses the additional water (during monsoon time) of an existing irrigation dam. The water would otherwise flow off without use for irrigation or hydropower. The author sees the project, similarly to the Chunchi Doddi project as an interesting project with very little concerns regarding negative sustainability issues.

#### **Environmental impacts**

Despite this environmental friendly project and the likely good stakeholder process, also here some issues regarding sustainability remain unclear and incorrect. First of all the project developer call the project a “relatively small facility with a maximum output of 22 MW”. This is not according the EB definitions of Small Scale hydropower.

The PDD claims that an “assessment of Environmental Impact due to the project activity has been carried out” which should have been linked to the PDD as Enclosure-I. Enclosure I could not be found in the PDD document and the author addressed to the responsible valuator, TÜV Rheinland. The valuator however did not comply its duty and did not give an answer have been sent.



The fact that the project uses an existing infrastructure and only additional water during the monsoon time, minimises the negative ecologic impacts. Under an ecologic viewpoint, bearing in mind that the statement bases only on a desktop study, this project gets the best notes.

### **Social issues**

The Stakeholder Process seems to be conducted in a good manner. “Stakeholders’ comments notification (in english and the local vernacular language) through regional and national newspapers for public hearing giving a one month ahead notice to attend was brought out requesting the stakeholders to participate and communicate any suggestions/objections regarding the project activity. The brief summary of the project was circulated to all the stakeholders before the hearing.”

Following the PDD the stakeholder process lasted one day and representatives “requested their suggestions/objections”. The PDD lists four compensation measures for the local population.

1. Steps have been taken to set up a computer lab in the local college.
2. The project proponents have initiated steps to provide free transportation to these children to and from school so that their education continues unhindered.
3. The project proponents are exploring as to how to set up a Clinic that would provide free consultation and medicines to the local inhabitants.
4. The project proponents have already extended financial support to a local effort of setting up a place of worship which had come to a standstill due to paucity of funds.

Those presents for the local population are generous, however since they are not finalised and formulated in a manner which is not binding, a signed agreement should be worked out. When realising those measures, the project can be voted as social sustainable and the whole project contributes extensively to Sustainable Development.

## 8. Conclusion

The CDM is an interesting mechanism to direct countries towards a sustainable development path. As shown above internationally financed and projects in developed countries have specific guidelines (laws) especially for the planning phase, further they go through an intense process with several public consultations (Tiwag, 2005). The CDM has to proceed several steps in the future, so that the sustainable development of projects is assured. The thesis shows that the CDM lacks of both, sustainability guidelines and a proper stakeholder consultation. This is analysed in an analytical study which is performed in the chapter 5.2 and in an empirical study by analyzing CDM projects in India.

The criteria catalogue developed in this thesis aims to direct Small Scale hydropower projects towards sustainability. This can guide countries abating mistakes and paying high social and environmental costs. The criteria catalogue can be implemented in different levels of the CDM where the most direct implementation of the catalogue is the adoption in the Gold Standard. The GS would set a reference for sustainable CDM hydropower which can be labelled.

Further the criteria catalogue can give a hand to DNA members to have indicators and benchmarks for implementing sustainability assessments of hydro plants in the host country approval. The shown in this thesis it is essential that DNAs' prescribe at least some sustainability criteria for promoting Sustainable Development. The catalogue can give a hand to DNAs having an orientation and background literature<sup>140</sup> for the development of an assessment. Or better, DNA take the whole catalogue as SD assessment. Furthermore DNAs should think about benefit sharing of CDM revenues. Some of the revenues should partly be used for promoting sustainability goals.

Concerning the CDM regulations, a modification of the promotion of sustainability in the CDM will better lead to a Sustainable Development. COP/MOP decisions commit hopefully on minimum requirements for projects and implement them in the methodologies e.g. AM 05 or ACM 002. If not the UNFCCC Executive Board should

publish sustainability criteria as an orientation for what is meant by Sustainable Development in the CDM. Regulations should not only be required for hydro but especially for end of pipe projects. Further thinkable modifications of the CDM consist of implementing higher compensation of certified sustainable projects (e.g. Gold Standard) for example with a higher amount of issued CERs’.

Hydro project developer can use the criteria catalogue as a draft for sustainable hydro development. Furthermore it might be possible for a project developer to argue that “green” hydropower facilities are not business as usual and thus additional. In India developers argue that their projects are additional because privately financed small scale. hydro is not common. As argued above this additionality proof is often doubtful, especially when more and more hydro projects will be realised.

Thinking about the future of the CDM and potential big hydropower plants it is necessary to find solutions for those issues. The thesis wants to take first steps on this field and sustainable hydro projects might find the same implementation in developing countries like once EIA and environmental laws had been established due to international (WB, ODA) requirements.

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<sup>140</sup> See therefore also Bratrich/Truffer 2001 and the bibliography categories

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## **Annex**

The Sustainable Development Assessment of the Gold Standard lists the following indicators which have to be checked (The Gold Standard, 2003: 24ff).

### **A: Environmental sustainability**

Water quantity; evaluates the project's contribution to water availability and access.

Number of people with access to water supply in comparison with the baseline.

Water quality; evaluates water quality locally and regionally in the project's area.

Water quality will be measured using concentration of main pollutants.

Air quality; evaluates local air quality. Air quality will be measured by comparing the concentration of most relevant air pollutants (e.g.: SO<sub>x</sub>, NO<sub>x</sub>, particulate matters etc.) generated by the project activity.

Other pollutants; evaluates reducing the flow of pollutants not already considered to the environment, including solid, liquid and gaseous wastes.

Soil condition; will be measured by comparing the concentration of most relevant soil pollutants, erosion and the extent of land use changes.

Contribution to biodiversity; indicates the change in biodiversity estimated on a qualitative basis considering any destruction or alteration of natural habitat compared to the without projects scenario

### **B: Social sustainability and development**

Employment; evaluate the qualitative value of employment; whether jobs resulting from the project are highly or poorly qualified, temporary or permanent.

Livelihoods of the poor; This indicator comprises a number of sub-indicators. Where a sub-indicator is not relevant to the project, it should be ignored.

(I) Poverty alleviation; evaluated by calculating the change in number of people living above income poverty line compared to baseline.

(II) Livelihoods of the poor: Contribution to equal distribution and additional opportunity for disadvantaged sectors, in particular marginal or excluded social groups.

Access to essential services; water, health, education, access to facilities, etc. Measured by the number of additional people gaining access in comparison with the baseline.

Access to affordable clean energy services; where of a relevant scale, security of energy supply.

Human Capacity; assesses the project's contribution to raising the capacity of local people and/or communities to participate actively in social and economic development. It comprises three indicative sub-indicators.

(I) Empowerment, evaluates the project's contribution to improving the access of local people to and their participation in community institutions and decision-making processes.

(II) Education/skills; assesses how the project activity enhances and/or requires improved and more widespread education and skills in the community.

(III) Gender equality; assesses how the project activity requires or enhances improvement of the empowerment, education/skills and livelihoods of women in the community.

### **C: Economic and technological development**

Employment (numbers); Employment generation measured by the number of additional jobs directly created by the CDM project in comparison with the baseline.

Sustainability of the balance of payments; net foreign currency savings may result through a reduction of, for example, fossil fuel imports as a result of CDM projects.

Hard currency expenditures on technology, replicability and contribution to technological self-reliance; As the amount of expenditure on technology changes between the host and foreign investors, a decrease of foreign currency investment may indicate an increase of technological sustainability<sup>141</sup>.

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<sup>141</sup> The GS explained this Indicator in further details (The Gold Standard 2003: 27). When CDM projects lead to a reduction of foreign expenditure via a greater contribution of domestically produced equipment, royalty payments and license fees, imported technical assistance should decrease in comparison with the baseline. Similarly a reduced need for subsidies and external technical support indicates increased self-reliance and technology transfer.