Watershed Management in the Upper Ciliwung River

S-Lab Project Spring 2009

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Executive Summary

United in Diversity (UID) is a Jakarta-based nonprofit organization promoting stakeholder dialogue to solve complex issues facing Indonesia. UID and the MIT Sloan School of Management co-sponsor IDEAS (Innovative Dynamic Education and Action for Sustainability) Indonesia, an educational program designed to develop leadership skills in diverse conditions. We, as students of the Sustainable Business Lab (S-Lab) course at MIT Sloan, have been working with a current IDEAS team to develop a workshop aimed to initiate a process of improving the ecology and water quality of the upper Ciliwung River outside of Jakarta. We conducted an analysis of the key stakeholders that must be a part of the discussion. Further, we investigated successful methods of hosting workshops aimed at stakeholder buy-in and ecological improvement. Finally, we made the recommendation to adopt a “portfolio approach” to mitigate the causes of the high levels of pollution in the Ciliwung River. This approach, rather than build upon large, expensive infrastructure projects, promotes a large number of small, inexpensive measures that, taken in concert, can quickly improve the watershed and ecology of the upper Ciliwung River.

Background

The “Jakarta water crisis” is a combination of watershed flooding problems in the rainy season, water quality issues as a result of upstream agricultural, domestic and industrial uses and scarcity of water supply due to the increased demand for access to clean water by households and industries. In addition, groundwater pumping is leading to sea water intrusion into the aquifer and accelerating the sinking of the city. The City of Jakarta raised prices of ground water to stop people from pumping, but with only 54% of Jakarta’s water needs met by the utility company, people don’t have a lot of options but to drill for ground water. The gravity of
the situation is highlighted by a World Bank study predicts parts of Jakarta will sink five meters by 2025 – 16 years from now\(^1\). UID teamed with the MIT Sloan School of Management and students of S-Lab to design and implement a stakeholder dialogue with the hopes of taking the steps to solve this crisis.

UID was formed after 2003 Bali bombings as an educational forum among the public, civic and private sectors to build trust among them in order to deal with Indonesia’s complex challenges and make progress to solve them. They focus on leadership education, community development, and public affairs in Indonesia. In addition, they are now starting to build an education academy to facilitate young Indonesian leaders from across sectors with a collective learning process to cultivate their bridging leadership capacity to support Indonesia’s sustainable development\(^2\).

The Ciliwung River runs from south to north, starting in the Puncak Mountains, going through Bogor, the city Jakarta and ending at Marina Beach in Jakarta Bay. The river is approximately 76 km in length with a catchment area of 322km\(^3\). The project starts with the upper portion of the river to focus on the upstream pollution sources, namely human and agricultural waste. Once the solutions are found, the UID can shift its focus downstream and replicate successful efforts there. Research shows that the problem is severe in the upper region itself, where the water quality drops significantly even before the river reaches the middle region.\(^4\) Given limited resources, the project would work in stages, starting with the upper region and working its way


\(^2\) UID. Personal Interview. 30 April 2009

\(^3\) Anita Sitawati, Diana Hendrawan, Melati Fachrul, “Land use and water quality relationships in the Ciliwung river basin, Indonesia”.

\(^4\) Ibid.
downstream toward Jakarta. Currently, UID is bringing stakeholders together and plans to use
the first workshop as a pilot for the remaining regions of the Ciliwung River and for other rivers.

**Scope**

After lengthy discussions with UID, the IDEAS team and the S-Lab team advisor, we settled on a
scope encompassing the following three areas:

- tools/thinking to identify the key stakeholders
- a recommended workshop agenda
- a list of some of the best watershed management practices from around the world

This organization of effort and thoughts makes sense. First, the team must find the key
stakeholders and the appropriate leverage points to entice them to attend the workshop. This
sets the stage for the relevance of the greater effort to solve the watershed management issues
plaguing the upper Ciliwung River watershed. With greater initial buy-in from the stakeholders,
the technical efforts on the river will be much greater as well. Much of the discourse and
decision-making will happen at the workshop. Hence, it is important to have a well thought out
agenda and location for the workshop. Finally, there is an extremely large amount of
information regarding watershed management techniques out there. Analyzing these
techniques and selecting what may work best for the specific issues facing those depending on
the Ciliwung River will be quite useful. Further, there are plenty of additional education and
technical resources available to UID and the IDEAS team that they can utilize for the
implementation of the final measures taken.
Stakeholder Analysis

UID “seeks to use dialogue and the exchange of broad-based ideas to promote the participation and inclusiveness of the private sector with the civil society and public sector in advancing Indonesia’s sustainable development and improving the quality of life for all its people.⁵” In order to most effectively promote the exchange of ideas around a central topic, it is important to understand the major stakeholders invested in that topic. When examining the issue of improving watershed management practices, one must first analyze the users of the watershed resource in order to determine the appropriate leverage points to bring the stakeholders to the table, so to speak. The workshop hosted by UID will need to attract the appropriate stakeholders with enticing reasoning and incentives. A thoughtful analysis of the stakeholder interaction with the watershed and with each other will uncover the appropriate leverage points. But first we turn to identifying the stakeholders.

Finding the right stakeholders

Oftentimes these users of a watershed are quite obvious. For example, the agricultural sector needs water for its crops and often uses irrigation as a means of delivering this water. Villagers living on the river must use water in their daily lives for drinking and cleaning. Some users, however, are not so obvious. The dairy, industry, for example, indirectly uses fresh water from the Ciliwung River. Figure 1 demonstrates the dependencies of the dairy industry on fresh water from the Ciliwung. We chose to analyze various methods of identifying stakeholders in order to ensure complete inclusivity. These methods range from analysis by sector to analysis by land type to analysis by industry.

⁵ http://www.unitedindiversity.org/
UID has identified a large number of stakeholders from three major sectors: the public, civil sector and private sector. The public sector, or the government, mostly includes government ministries. The civil sector includes local nonprofits and NGO’s, universities and small villages and suburban communities. The private sector includes such parties as the dairy industry, tourism industry, agriculture industry and private landowners. Figure 2 illustrates the stakeholders as categorized into the three sectors.

Figure 2. Key stakeholder categories defined by UID

The second method we used was an analysis by land type. Fachrul, Hendrawan and Sitawati identified five major uses of the land in the Ciliwung River watershed. They divided the land use into five (5) classes: (1) land use for agriculture, (2) land use for wet land and water body, (3) land use for settlement, (4) land use for industrial estate, and (5) land use for business

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services. Tables 3 and 4 indicate the land use in Ciliwung River basin over time.⁷ These figures show that the developed uses of land have increased dramatically and while the amount of land used for agriculture has decreased, it still represents a large portion of the land use.

Table 3. Land Use around Ciliwung River – max upstream by settlement⁸

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Upstream</th>
<th>Middle Area</th>
<th>Downstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Space</td>
<td>21%</td>
<td>13%</td>
<td>2%</td>
</tr>
<tr>
<td>Settlement</td>
<td>51%</td>
<td>58%</td>
<td>62%</td>
</tr>
<tr>
<td>Industry</td>
<td>3%</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>Street</td>
<td>12%</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>Office Park</td>
<td>2%</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>Trade Park</td>
<td>11%</td>
<td>5%</td>
<td>7%</td>
</tr>
</tbody>
</table>

⁷ Anita Sitawati, Diana Hendrawan, Melati Fachrul, “Land use and water quality relationships in the Ciliwung river basin, Indonesia”.
⁸ IBID
### Table 4. Land Use Change of Ciliwung River Basin (1970-2000)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ha</td>
<td>% area of river basin</td>
<td>Ha</td>
<td>% area of river basin</td>
</tr>
<tr>
<td><strong>UNDEVELOPED AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land for Farming and Green Open Space</td>
<td>15,312.13</td>
<td>39.55</td>
<td>13,817.70</td>
<td>35.69</td>
</tr>
<tr>
<td>Wet Land and Water Body</td>
<td>10,375.86</td>
<td>26.80</td>
<td>8,656.87</td>
<td>22.36</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>25,687.99</strong></td>
<td><strong>66.35</strong></td>
<td><strong>22,474.57</strong></td>
<td><strong>58.05</strong></td>
</tr>
<tr>
<td><strong>DEVELOPED AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Settlement</td>
<td>12,060.00</td>
<td>31.15</td>
<td>12,385.21</td>
<td>31.99</td>
</tr>
<tr>
<td>Industry</td>
<td>193.58</td>
<td>0.50</td>
<td>1,711.24</td>
<td>4.42</td>
</tr>
<tr>
<td>Business Services</td>
<td>774.32</td>
<td>2.00</td>
<td>2,114.86</td>
<td>5.54</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>10,027.90</strong></td>
<td><strong>33.65</strong></td>
<td><strong>16,241.31</strong></td>
<td><strong>41.95</strong></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>38,715.89</strong></td>
<td>100.00</td>
<td><strong>38,715.88</strong></td>
<td>100.00</td>
</tr>
</tbody>
</table>

A third method of stakeholder analysis is to look at industry type. One can look at private use for personal home, office buildings or hotels. Further, there are multiple types of agricultural industries in the upper Ciliwung River watershed, including rice and dairy. Separating the stakeholders into these types of categories is useful for a leverage point analysis. Prioritizing those who depend on the Ciliwung River for drinking water supply is useful as they are the most incentivized to participate in the workshop and in any efforts to improve watershed management. Those that use the water for agricultural and industrial purposes are more focused on the price of water. If potential solutions to the water crisis were to include changed in the price of water available to these industries, those industries would certainly be motivated to participate at a higher level.

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9 Anita Sitawati, Diana Hendrawan, Melati Fachrul, “Land use and water quality relationships in the Ciliwung river basin, Indonesia”.
Aside from industry, the amount of settlement is disconcerting. Much of the settlement is not from the marginalized poor settling along this river, but from the wealthy urban population building vacation homes up in the mountains. Utilizing large portions of upland land only pushes the rural poor closer to the river’s edge. Higher levels of settlement on the river lead to more numerous problems for the watershed. Many more people are now dependent on the Ciliwung for waste disposal and drinking water. Indeed this is a vicious cycle that works in contrast to the goal of improved watershed management and ecological health. This situation intimates that there are ethical issues associated with the management of this watershed and the surrounding land. There is a responsibility to provide drinking water for the inhabitants of this area first and foremost. Further, this is need to provide these people with land away from the river in order to protect this natural resource. Without action, more than industry will die – people will.

**Examining leverage points**

With a list of key stakeholders, one can begin to examine their interactions with each other and with the watershed in order to find their leverage points. Detailed analysis of the leverage points can be found in Appendix A. Table 5 lists the major stakeholders and their associated leverage points. With these leverage points, it is possible to approach each stakeholder and discuss the importance of proper wastershed management not just for the people who rely on it most or for the people in Jakarta, but for each individual stakeholder. Once each stakeholder understands his/her own leverage point and those of others, a constructive dialogue can begin.

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10 UID. Personal Interview. 30 April 2009.
Table 5. Major stakeholders and leverage points

<table>
<thead>
<tr>
<th>Major Stakeholders</th>
<th>Leverage Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>UID</td>
<td>Organizer of Workshop</td>
</tr>
<tr>
<td>Ministry of Forestry</td>
<td>Mission of agency</td>
</tr>
<tr>
<td>Ministry of Environment</td>
<td>Mission of agency</td>
</tr>
<tr>
<td>Conservation International</td>
<td>Mission of agency</td>
</tr>
<tr>
<td>Villagers on River</td>
<td>Access to clean drinking water</td>
</tr>
<tr>
<td>Tourism Industry</td>
<td>Water necessary to attract tourists; cost of clean water; robust ecosystem</td>
</tr>
<tr>
<td>Dairy Industry</td>
<td>Water necessary to attract tourists; cost of clean water; robust ecosystem</td>
</tr>
<tr>
<td>Agricultural Industry</td>
<td>Water necessary to attract tourists; cost of clean water; robust ecosystem</td>
</tr>
<tr>
<td>Additional industries</td>
<td>Water necessary to attract tourists; cost of clean water; robust ecosystem</td>
</tr>
</tbody>
</table>

Figure 4. Analysis of dairy industry within Ciliwung hydrologic cycle.
**Workshop Agenda**

For the workshop there should be two categories of attendees. First, the hosts, UID and the IDEAS team, should also play the role of the facilitators. The second type of attendee includes the stakeholders. These are identified through the process described in the section above.

**Pre-workshop**

After identifying the stakeholders, the facilitators should speak to each one individually before the workshop. This would help set expectations, as stakeholders would come prepared with real concerns and actual stories that would help them structure the discussion better. Since facilitators would also generate discussions around a topic and allow the group to exchange ideas openly, they should prepare material before the workshop to guide discussions.

**Venue**

The venue should preferably be chosen to highlight the problem. Something close the river would be ideal, but if not, then visual imagery, movies or presentations should be used to put people in the right frame of mind to visualize the problem and solve it.

**Workshop**

An ideal time for the workshop would be two days, but, given stakeholder availability, a one day workshop would also suffice. The idea behind the workshop is to ensure dialogue between stakeholders. The workshop should be started by laying out the problem and stakeholders to think about how they relate to it. Next, it is helpful to educate them about the system dynamics approach explaining how each stakeholder contributes to the current water crisis in order for each stakeholder to understand how the others fit in the picture. Further, the facilitators should show stakeholders existing solutions and best practices from around the
world. Finally, there should be time to allow stakeholders to think through and choose which watershed management practices works best for each group. The workshop should not be a debriefing session but a brainstorming session, as people think through the problem and choose their own set of solutions they will be more committed to the project, ensuring that solutions are implemented. This is extremely important, for given Indonesia’s current economic situation, legal framework and the extent of the crisis, the situation will not be solved by formulating laws but getting all the stakeholders involved.

**Workshop Design**

We researched workshop design, looked at different sustainability workshop agendas, spoke with an MIT professor skilled in stakeholder dialogue and came up with the following recommendations for how the day should be structured:

- **Welcome** – The welcome should include activities for people to get to know each other.
- **Energizer/Mixer** – This session will allow people to share their stories and experiences. This helps people step away from their pre-existing mental framework and get to know each other.\(^\text{11}\)
- **Summarize the Issue** – Here the facilitators present the problem, educate people on the extent of the crisis and highlight the urgency of the situation. This should be carefully executed such that nobody is blamed for the problem. It should be a summary of facts, figures and pictures, all highlighting need for immediate action.
- **Breakout Sessions** – Here the stage is set by reviewing the goals of the workshop and by discussing the role of facilitators. Divide participants based on backgrounds, experience, and

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\(^\text{11}\) Professor Otto Scharmer. Personal Interview. 5 May 2009.
interests into pre-planned/or self-selected groups. Facilitators would generate discussions around a general topic and allow the group to exchange ideas openly. The aim is to get stakeholders to brainstorm on what they think the key issue is and where the solutions lie.

- **Education** – In this portion of the workshop everyone will be brought together and debriefed on each group’s takeaways. Then the facilitators will educate the group on existing best watershed management practices from around the world.

- **2nd Breakout Session** – The groups will again break out into their own discussions regarding which of the existing watershed management practices work for them or if they believe different solutions are needed. Each group should have a sense of what they want to adopt and think about the next steps.

- **Goal** – The goal of this workshop is to create an action plan for watershed management for each set of stakeholders. All discussions must be interactive, with participants feeling that they are part of something, and have come up with the solutions. There should be consensus on the action plan. This may not be a firm plan to adopt specific technologies to mitigate the problems of the watershed. Rather, next steps may include the formation of subcommittee and the scheduling of subsequent meetings. Ideally, there will be specific actionable items that will be completed by a specific date.

**Breakout Sessions**

The breakout sessions should cover issues concerning all stakeholders as they look at their respective roles in watershed management. Some areas to consider in the breakout discussions could include issues of communal rights, social equity, education, media, ethics and politics.
Below is a summary of some useful breakout sessions we saw in a stakeholder dialogue for the cement industry in Thailand and for a watershed management process in Zimbabwe.

- **Communication, Dialogue, and Social Aspects:** Focus on dialogue and different means of communication not only between stakeholders but also with the wider community. This should also include the issue of socio-economic development as we are looking at rural settings, lack of infrastructure and vulnerable poor communities\(^\text{12}\).

- **Business Practices and Governance:** The workshop should look at how public policy would be created, monitored and implemented. This also applies for measurement tools to track progress of initiatives undertaken, and means to promote and push for sustainable development\(^\text{13}\). An example of a successful governance method includes the formation of a local committee aimed to have ownership of its own section of the watershed\(^\text{14}\).

- **Technology, Environment, and Innovation:** The workshop should consider areas of global warming initiatives, any new innovations, the health of the environment including the land and air, biodiversity, industrial ecology and the health of the people around the river\(^\text{15}\).

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\(^{13}\)IBID.


Watershed Management and Ecological Improvement

UID’s focus has all along been one of stakeholder dialogue and opening communication between previously disparate parties. It is understood, however, that the long-term goal is sustainable watershed management and ecological health in the Ciliwung River and beyond. With Jakarta’s looming water crisis, quick, inexpensive and easily implemented solutions are preferred over large, costly infrastructure projects. One basic framework to use when utilizing a portfolio approach to water management is to look at each type of water (e.g. white water, grey water and black water) separately and to choose the right technologies for each type separately.

**White Water**

White water, or potable water, in the upper Ciliwung River is comprised of surface water from the Ciliwung River itself. Depending on whether or not the removal point is upstream or downstream of the point source pollution sources, that water may be clean or not. In either case, it is a good idea to perform some sort of treatment on the water before it is consumed. Some of the most widely used methods include sedimentation, filtration and sterilization. More details about existing methods for treating white water are included in Appendix B.

**Grey Water**

Grey water is the water resulting from bathing, doing laundry, washing hands, etc. This water can typically be used for irrigation and watering and can thus be kept from re-entering the source from which it came. With little existing infrastructure, there may be little opportunity
for households in the upper Ciliwung area to utilize grey water recuperation, but the area hotels and industries will. Separating grey water from the sewage system will allow these organizations to reduce costs devoted to water usage for landscaping and irrigation. One opportunity for implementing a grey water system in a community setting is available for relatively low cost. Chores that take place in the river and serve as a socialization mechanism can be replicated in community watering areas that take advantage of grey water capture methodologies. More details about existing methods for treating grey water are included in Appendix B.

**Black Water**

Black water may be the most urgent issue facing the stakeholders at the workshop. Large portions of the river banks are populated with poor villages lacking basic plumbing. Because of this, human waste has become one of the largest pollutants in the Ciliwung. Therefore, solutions that directly alleviate the human waste issue are vitally important. Today, there are a large number of solutions implemented throughout the world that tackle just such a problem. More details about existing methods for treating black water are included in Appendix B.

An additional source of black water when there is no sewage system is animal waste. UID estimates that at each dairy farm there are approximately 3000 cows producing 5 kg of waste each day.\(^\text{16}\) If even a small percentage of that waste enters the river, there will be high levels of pollutants present that prevent use as drinking water for a large number of people. A popular method for dealing with animal waste is to produce biogas. Producing biogas can solve two

\(^{16}\) UID. Personal Interview. 30 April 2009.
problems: waste disposal and energy production. Further, producing energy through biogas can even generate additional income for dairy farmers and produce additional jobs for the operation of the biogas system.

**Ecological Restoration**

Watershed management, while essential in the process to provide ample clean water for the people of the Ciliwung River watershed and the people of Jakarta, is only half of the solution. A larger understanding of ecological restoration must be implemented to ensure the health of the river. Various animal and plant species that make up the river’s ecosystem must be restored and maintained. The presence of plant life and the maintenance of a river’s natural meandering path can slow down water flow in times of high rainfall, perhaps decreasing the severity of flooding further downstream.

**Other Resources**

In addition to utilizing existing technologies, there are numerous other resources devoted to such projects as the improvement of watershed management in the upper Ciliwung River. Organization such as Clean Water Fund, Global Water Fund and the World Water Forum are all devoted to such improvement. Further, there are numerous researchers in the academic field that contribute to the study of watershed management. More details about additional resources are included in Appendix B.
Other Considerations

In addition to the numerous hydrological and ecological challenges, there are numerous social challenges to consider. For many rural Indonesians, the river provides a place in which to socialize.\(^\text{17}\) Replicating these social interactions in a manner that produces fewer negative ecological externalities is critical to ensuring the success of the program. For example, if women in the area use the time spent performing chores on the river to socialize, there needs to be a viable alternative to ensure buy-in. One alternative may be a common wash area with several spigots of clean, fresh that can be used for cooking or cleaning. The drains can feed a grey water irrigation system, thus decreasing the runoff of pollutants into the river. Solutions like these can be implemented rather quickly while taking into consideration the social situation in which they are implemented.

On a much larger scale, there is the question of social equity in general. Why have the rural poor been marginalized to the river side? Is it due to the access to the river or the lack of land ownership rights in the upland areas? What can the government do to incentivize the people to move upland from the river in order to decrease the possibility of human waste entering the river? This discussion may not be appropriate for the initial workshop but nonetheless should be raised at some point in this process.

\(^{17}\) UID. Personal Interview. 30 April 2009.
Conclusion and Next Steps

UID and the IDEAS team have embarked on this project with the intention of creating a successful dialogue among stakeholders within the upper Ciliwung River. By identifying the key stakeholders, finding the appropriate leverage points, hosting everyone at a workshop and educating them about successful watershed management strategies, everyone can begin to create positive change in the watershed. With the contents of this report, all of these actions can be taken.
Sources

- UID. Personal Interview. 30 April 2009.
- Scharmer, Otto. Personal Interview. 5 May 2009.
Appendix A – Stakeholder Analysis Tools

**Stakeholder Analysis Tool: Industrial Water**

- **Suppliers**
  - Water Utility
  - Surface Water
  - Ground Water

- **Fresh Water Users**
  - Agriculture
  - Leather Industry
  - Resorts

- **Buyers**
  - Clothing manufacturers
  - Food distributors

**Example Questions to ask**

- What are the inputs for each water user’s product?
- How much water is used?
- Are there alternative methods that use less water?
- What are their customers concerns?
- How sensitive are the customers to price?

**Stakeholder Analysis Tool: Drinking Water**

- **Suppliers**
  - Water Utility
  - Surface Water
  - Ground Water

- **Drinking Water Users**
  - Villagers
  - Resorts
  - Bottlers

**Example Questions to ask**

- Is there a market for water?
- Is there sufficient knowledge regarding the health risks of unclean drinking water?
Appendix B – Water Treatment Technologies and Resources

**White Water**
- Sedimentation
- Filtration
  - Sand and charcoal filtration systems
  - Kanchan Arsenic Filter
- Disinfection
  - Chemical Disinfection
  - Solar Disinfection (SODIS)
  - boiling
  - pasteurization
  - ultraviolet disinfection

**Grey Water**
- Groundwater recharge
- Topsoil nutrification
- Reduced energy use from treatment later in the hydrologic cycle

**Black Water**
- Composting Toilets
- Pee Poo Bag: [http://www.peepoople.com](http://www.peepoople.com)

**Other Resources**
- Researchers:
  - Susan Murcott, MIT
- Organizations:
  - Cleanwaterfund.org
  - Globalwaterfund.org
  - Wateraid.org
  - USAID