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SUSTAINABLE DEVELOPMENT OF WATER RESOURCES, WATER SUPPLY AND ENVIRONMENTAL SANITATION

Capacity Needs to Achieve the UN MDG Target 10 in Asia

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A preliminary study is conducted in Asia to assess the capacity needs to achieve the UN Millennium Development Goal 7, Target 10 on water supply and sanitation. Needs assessment methodology, compatible with that proposed by the UN Millennium Project, is adopted. Data is gathered by interviewing 66 selected respondents in Bangladesh, China, India and Nepal. In addition, a few projects are analysed for the involvement of professionals. Respondents find that engineers lack managerial skills as well as understanding of social realities. Engineering students are not enough exposed to real-life engineering practice. Curricula and research are insufficiently oriented towards local circumstances and needs. Institutions of higher education lack physical facilities and financial and, consequently, human resources. Analysis of several water supply and sanitation projects reveals that about 20% of professional staff is needed for community mobilisation, in order to ensure the success and sustainability of projects.

Introduction

Background on Millennium Development Goals

THE UNITED NATIONS Millennium Declaration formally represents the commitment of the world community to significantly improve living conditions of millions of people in need. The Declaration has led to the formulation of eight goals in total; for each goal specific targets have been set, most of them to be achieved by year 2015, using year 1990 as the baseline (UN, 2000). The UN Millennium Project has issued a handbook that is to serve as a guideline for individual countries in preparing their national strategies (UN Millennium Project, 2005c).

Access to water supply and sanitation is vital for people's health, dignity and development. Appropriately, the 7th Millennium Development Goal 'Ensure Environmental Sustainability' includes Target 10 that addresses issues of water and sanitation: 'Halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation' (UN, 2000). Moreover, water supply and sanitation are recognised as instrumental in achieving other MDGs, as elaborated in the UN Millennium Project documents (UN Millennium Project, 2005b; 2005c).

In order to provide a framework for the actions required to achieve the Goal, the UN Decade for Action 'Water for Life' was launched in March 2005. In addition, the UN Millennium Project Task Force on Water and Sanitation has produced a comprehensive document on this UN MDG target only (UN Millennium Project, 2005a).

Problem Identification

In terms of the UN Millennium Project Handbook, interventions undertaken to achieve the MDGs comprise both policies and investments (UN Millennium Project, 2005c). A genuine political will is perhaps the most critical issue in achieving the MDGs (WSSCC, 2004). Provided that the genuine political will is present – both within countries and internationally – the countries need human resources, infrastructure and financial resources for a successful formulation and implementation of MDG strategies. Human resources are arguably the key element, as they bring political decisions and strategic documents into life.

This is confirmed time and again by past experiences of various organisations at national and international levels. For example, many infrastructure projects undertaken in developing countries during the International water supply and sanitation decade (1980–1990) have failed to deliver the expected benefits. Most failures can be attributed to inappropriate technology selection, lack of community participation and mobilisation, and insufficient attention to operation and maintenance issues (World Bank, 1990). In turn, these can be traced back to a lack of capacities in communities and organisations involved in the projects.

International agencies and national governments have increasingly recognised the importance of capacity building for sustainable development in general and for sustainable management of water resources and delivery of water supply and sanitation services, in particular. Examples include the New Delhi Statement prepared at the Global Consultation on Safe Water and Sanitation for the 1990s (Anonymous, 1990) and the Water-Education-Training (WET) strategy for institutional and human capacity building in the water sector developed after the Second World Water Forum (Bogardi and Hartvelt, 2000).

UNESCO-IHE Institute for Water Education has a prominent role in strengthening and mobilising the global knowledge base for integrated water resources management.

In order to fulfil this role accordingly, UNESCO-IHE has initiated this preliminary study to assess the need for professionals in water-related fields in Africa, Latin America and Asia. This paper presents the findings on Asia.

Objective of the Study

The main objective of the study is to assess the needs for engineering professionals at postgraduate level to meet the Target 10 on water supply and sanitation of the United Nations Millennium Development Goals.

In order to achieve the main objective of the study, the following specific objectives have been defined:

- To identify the main hindering factors in efforts to achieve the MDG Target 10 in selected countries;
- To evaluate the possible gap in availability of professionals in the water supply and sanitation field;
- To evaluate the role and the contribution of institutions of higher education in achieving the MDG Target 10.

Needs Assessment Methodology

In order to support national governments in their efforts to achieve the MDGs, the UN Millennium Project has issued a handbook on preparing national strategies (UN Millennium Project, 2005b). As a part of the methodology proposed, assessment is recommended of needs in terms of human resources, financial resources and infrastructure necessary for meeting the Goals. As this study assesses the needs for one type of human resources – engineers at postgraduate level – as such it very well fits into the methodology proposed by the UN Millennium Project.

Needs assessment is a formal, systematic procedure undertaken to help decision-makers identify, understand, and eventually overcome a gap in a certain area of public or corporate interest. The process is usually expected to pinpoint the reasons for gaps in performance, and to suggest, based on the needs identified, policy priorities such that future action (interventions) and allocation of resources will result in improvement desired (Reviere *et al*., 1996; UNDP, 1998).

In this study, three distinct activities have been conducted: literature study of relevant (inter)national documents, individual interviews with selected respondents, and the analysis of professional staff involved in several water supply and sanitation projects.

Formal questionnaires have been developed to guide the interviews in a structured manner (Foddy, 1993). Mostly open-ended questions are used, in order to allow the respondents to fully express their opinions and expertise. The developed questionnaire has been pre-tested for clarity and completeness. The interviews have been held in person, in the premises of interviewees. Where permitted, the interview sessions have been recorded.

Selection of Representative Countries

The Asian continent comprises 49 countries, with highly diverse natural conditions, social and cultural practices, and the levels of economic and technological development. In order to represent the Asian continent, a set of selection criteria has been established regarding the objective and the scope of this study. The following criteria have been used: population that lacks water supply and sanitation facilities (both as absolute numbers and as percentages of the country's population) and Human Development Index (HDI).

According to these criteria, Bangladesh, China, India and Nepal are selected. China and India are selected to represent the majority of people without access to water supply and sanitation. To represent medium-large countries, Bangladesh is selected over Indonesia due to its low HDI (0.50 in Bangladesh v. 0.68 in Indonesia). Nepal is selected to represent small countries as it has a HDI of 0.50 and because regional UNICEF office and SAARC secretariat are situated there.

The above countries represent about 80 % of Asian population that lacks water supply and about 84 % of Asian population that lacks sanitation.

Selection of Respondents

In order to appropriately represent the broad range of interests and roles of key stakeholders involved in the issue, the following main groups have been distinguished:

- Water and sanitation sector, organisations involved in planning, design, implementation, operation and maintenance of water supply and sanitation projects;
- Institutions for higher education in water and sanitation;
- Organisations directly involved with the Millennium Project in the selected countries.

Within these groups, experts belong to one of the following types of organisations: national governments, regional/state governments, local governments; water supply and sanitation services providers; non-governmental organisations; United Nations local offices involved in water and sanitation such as UNESCO, UNICEF, UN-Habitat, WHO; international organisations in water supply and sanitation (WSSCC, World Bank's Water and Sanitation Program); funding and development aid agencies such as the World Bank and the Asian Development Bank, Water-Aid and Danida; universities, research institutes, resource and training centres; associations and organisations of professionals.

In total, 66 experts were interviewed, whereof 10 in Bangladesh, 11 in China, 16 in India and 29 in Nepal, the country of origin of the second author.

Results

In any study of this nature a legitimate question arises about the selection of a statistically representative number of respondents. This has certainly not been the case in China and India. Therefore, the results presented can only be taken as an indication of the actual situation.

Activities on water supply and sanitation

Policies and plans are in place in all four selected countries (Bangladesh, China, India, Nepal) that address the issues

related to water supply and sanitation. The plans are not necessarily prompted by the MDGs, but are rather the result of long-term development policies. Problems of slum areas, however, have been long discussed but have not yet been addressed adequately. Most respondents agree that the existing policies are appropriate to achieve the MDG targets on water supply and sanitation in their respective countries. As a rule, the planning targets have been very optimistic and have usually not been met in the past planning periods. Yet, the countries have set ambitious targets beyond MDGs to be achieved ahead of 2015.

Factors hindering the achievement of the MDG targets

Respondents were divided in their opinions in Bangladesh, China and India on whether the MDG targets will be achieved in their respective countries. Nepalese respondents were of opinion that the targets will not be achieved.

In all the sample countries the progress towards the target on sanitation is lagging behind that on water supply. This area seems to be of lower priority not only to policy makers but also among the male population of the sample countries. In the Nepal's country MDG progress report, sanitation is not even mentioned.

The issue of hygienic habits was raised as equally important as sanitation services in all four countries. It was stated that the awareness is often lacking among people about the importance of such habits.

Table 1 presents respondents' opinions on the critical factors hindering achievement of development goals in water and sanitation in their respective countries.

Respondents in Bangladesh, India and Nepal cited lack of political will as *the critical factor* hindering the achievement of MDG targets. Also Chinese respondents emphasised the need for a strong political commitment. The responses confirmed the earlier mentioned statement by WSSCC (2004) about the vital importance of genuine political will. Chinese respondents cited lack of water resources as the most significant obstacle for the achievement of MDG targets. Indian respondents also included water scarcity in top three hindering factors.

Table 1. Critical factors hindering development of water supply and sanitation services

Factor lacking	Bdesh	China	India	Nepal
Water resources		1st	3rd	
WS&S engineers	3rd			
Other professionals	2nd			3rd
Institutional capacity	2nd	3rd	3rd	2nd
Financial resources		2nd	2nd	1st
Political will	1st		1st	1st
Other				

1st - highest priority.

Box 1. Water scarcity in China

The availability of water resources is a great challenge for China in its attempts to meet the MDG 7. On I to IV scale China is placed in category I, which signifies absolute water scarcity (Seckler *et al.,* 1999). Northern part of China experiences most serious shortages. Whereas country average is 2,186 m^3/person, in some areas it is as low as 360 to 750 m^3, compared to the international definition of water scarcity that is set at 1,000 m^3/person.

In addition to water scarcity, the inadequate quality of water that *is* available severely aggravates the problem. Due to natural presence of arsenic and fluoride in exceedingly high concentrations in groundwater in Bangladesh, India and Nepal and intrusion of salinity in Bangladesh and India, the existing water resources cannot be considered safe for human consumption without treatment.

Box 2. Depletion of groundwater in India

A highly subsidised electricity tariff for irrigation tube wells in India has led to an indiscriminate and disproportionate extraction of groundwater for irrigation, and subsequent depletion of groundwater reserves, which, in turn, has aggravated problems with presence of arsenic, fluoride and salinity (e.g., Shukla, 1999; Mazumdar, 2001).

Only 5% of groundwater is used for meeting drinking water needs, whereas 85% of rural water supply systems rely on groundwater.

Much more serious is the pollution of water resources by anthropogenic sources, as emphasised by respondents in all four countries. The sources of pollution include: animal and human excreta, untreated industrial wastewater and sewage, pesticides and fertilizers from agriculture, and leachate from solid waste disposal sites. Half of China's population (nearly 700 million people) consumes drinking water that is contaminated with animal and human waste and thereby exceeds the applicable standards. Among 27 largest Chinese cities, only in six of them drinking water meets official standards (Genesis Technology Group, 2003).

Lack of financial resources was placed in the top three priorities in Nepal, India and China, but only in Nepal as the critical one, together with political will, where the projects are started without sufficient financial resources allocated (Table 1). Bangladeshi respondents did not place the lack of financial resources in top three factors hindering achievement of MDG targets. In their view, the issues of political will and institutional capacity combined with human resources are more critical at the moment.

Institutional Capacity

Respondents in all four countries cited lack of institutional capacity as one of the top three factors hindering achieve-

ment of the MDG target on water and sanitation.

According to the respondents in China and India, co-ordination of efforts and co-operation between government departments and agencies as well as clear rules of accountability are lacking.

A clearer demarcation of roles and responsibilities, capacity building and upgrading of skills, particularly at municipal level, sharing experiences and knowledge among practitioners, as well as record keeping and information systems, are needed to improve the situation. Effective and regular monitoring and evaluation of water supply and sanitation programmes are also needed. In addition, a need is identified to establish effective cost recovery mechanisms.

In the current trend of decentralisation of services, problems of poor co-ordination of efforts and lack of co-operation have become even more evident than before in India and Nepal. Respondents cited an ineffective coordination between various government agencies and non-governmental organisations as well as a lack of clarity in the decentralisation of authority to local bodies and beneficiary groups. This has led to fragmented initiatives, unnecessary overlaps and conflicts and consequent inefficient use of scarce resources.

Box 3. Decentralisation programmes in India

In rural India, decentralisation programmes that institutionalise role of communities in partial financing and in operation and maintenance of water supply and sanitation services may be a very significant step towards achievement of MDG targets, as almost three quarters of Indian population live in rural areas.

Respondents were much more positive on this issue in Bangladesh, where stakeholders such as NGOs and CBOs have been increasingly – and successfully – involved. In recognition, Government's Department of Public Health Engineering (DPHE) is changing its role from service provider to a facilitator.

From the analysis of a few projects, it was found that number of human resources required is highly associated with the total cost of the project rather than with population to be served by the project. This is to be expected, as costs are usually correlated with the technology applied and for more advanced technologies more educated engineers are needed. However, respondents emphasised that educated professionals are needed in low-tech projects as well, in conceptual and planning stages.

Box 4. NGO Forum in Bangladesh

The NGO Forum has established offices in 14 regional centres and works with 650 partner organisations at community level. Through awareness raising and social mobilisation activities the NGO Forum has been effectively contributing to a better community participation in various community-managed water supply and sanitation projects (Halder, 2002).

Respondents estimated that for water supply and sanitation projects, about 20% of professional human resources need to have social sciences background, to adequately address issues related to community mobilisation that is necessary for the success and sustainability of water supply and sanitation projects.

Human resources

Availability of professionals

As presented in Table 1, the lack of engineers was cited in top three hindering factors in Bangladesh and other professionals in Bangladesh and Nepal. In China and India, political will, water resources, finances and institutional capacity were found more critical for the achievement of the MDG targets. When asked explicitly whether there are sufficient professionals to achieve the MDG targets in their respective countries (even if this is not a critical factor), the respondents in Bangladesh considered the number insufficient, majority of Nepalese respondents were of opinion that there are sufficient professionals, whereas responses in China and India were inconclusive. The results are presented in Table 2.

Bangladeshi respondents estimated that a total of around 300 engineers with a Masters degree are working in the field of water supply and sanitation in Bangladesh. As mentioned earlier, the respondents considered this number of Masters to be insufficient. Experts from universities said, though, that the number of *graduates* is sufficient to meet the MDG targets; however, not all of these graduates actually work in the field. Estimated 30% of them migrate to work overseas or switch to other sectors, in search for better professional and/or financial opportunities. Some of the experts interviewed estimated that additional 400 M.Sc. engineers are needed to ensure implementation of the national policies in water and sanitation (Rodić and Sah, 2005). With the current rate of 35 graduates per year (as presented in Table 3), the existing institutions of tertiary education cannot produce these professionals in time.

An unpublished China SEPA document cites 25787 as the total number of professionals at senior and middle levels working in environmental protection field in China in the year 2000. It was difficult for the experts to specify further how many of these are working in water supply and sanitation. Similarly, the responses were inconclusive regarding whether there are sufficient professionals to achieve the MDG targets in China.

Table 2. Are there sufficient professionals to achieve the UN MDG 7 Target 10 on water and sanitation?

Respondents answers	Bdesh	China	India	Nepal
Yes	2	1	6	15
No	6	2	5	5
Not sure	0	2	0	2

Figures represent number of responses.

In India, the number of engineers working in water and sanitation field was last ascertained by the CPHEEO during the International Water Supply and Sanitation Programme (1980-1990), after which it has not been updated. According to this source, some 11400 engineers at M.Sc. and B.Sc. levels were active in India in 1985 (Rodic and Sah, 2005). At expressing their opinions regarding whether the number of M.Sc. professionals is sufficient to ensure implementation of the national policies in India, all experts from educational institutions reported lack of professionals whereas experts from other organisations were divided. The reason for this could be that for most positions in the field only a Bachelor degree is required.

Nepalese respondents estimated the number of M.Sc. professionals in the country at about 180, which is roughly confirmed by the data from the Society of Public Health Engineers. Experts found this number sufficient to carry out national policies, certainly at current rate of investment.

The annual intake capacity and the graduation rate at the educational institutes offering Bachelor and Master level courses, as estimated by respondents, are presented in Table 3.

Respondents in all four sample countries cited a significant loss of graduates to other fields. As mentioned earlier, this is about 30% in Bangladesh. In China about 10% of graduates are estimated to change to other fields, mainly information technology, which is a flourishing business in China at the moment, or leave the country. Indian respondents estimated that about 20% engineers depart from water supply and sanitation field, attracted by better opportunities in other fields or abroad. Similarly to China, information technology is a booming business in India as well. An emigration rate of students of some 25% is reported by Forbes (2003), with 40% figure for undergraduates and lower for graduates. Respondents estimated that about 10% of engineers abandon the field of water supply and sanitation in Nepal.

Professionals needed

From experts' responses, it is clear that the competencies that engineering professionals (may or may not) have acquired during their formal education are at least equally important than the number of young people with a relevant diploma in their hands.

Bangladeshi experts were unanimous that young engineering professionals should be developed to contribute to the planning and implementation processes in which water quality aspects, health risk assessment issues and consumer satisfaction would receive due attention. Furthermore, they identified a clear need for good managerial skills. Besides the need for additional engineers, Bangladeshi respondents also cited the need for other professionals, particularly those with social sciences background. This is based on their experience that community participation is a prerequisite for a successful implementation and sustainability of water supply and sanitation projects.

Very similarly, Indian respondents pointed out that engineers lack managerial knowledge, skills and experience, as well as the lack of knowledge about and sensitivity to social aspects, which are particularly needed for projects in rural areas. This result is, in turn, very similar to that obtained in our study in Latin America (Mejia-Velez and Rodić, 2005).

The need for M.Sc. level professionals in Nepal varies per area: rural areas, small growing towns and urban areas. In rural areas community-based programmes are launched, implementation of which does not require high educational level professionals. At planning stage, however, as well as for coordination, monitoring and troubleshooting, these programmes do need M.Sc. level professional input. In small towns and urban areas, highly qualified professionals may be required depending upon the type of technology applied. Professionals are also needed for infrastructure development and utility management.

Table 3. Number of educational institutions offering relevant bachelor and post-graduate level courses

Country	Type and level of education	Number of institutions	Yearly intake	Yearly graduates
Bangladesh	Civil engineering (B.Sc. level)	6	400	280
	Environmental engineering (Postgraduate level)	4	70	35
China	Civil engineering (B.Sc. level)	100 in total		8000
	Environmental engineering (Postgraduate level)			3335
India	Civil engineering (B.Sc. level)	277	17000	11050
	Environmental engineering (Postgraduate level)	70	1400	910
Nepal	Civil engineering (B.Sc. level)	**9**	**450**	**290**
	Environmental engineering (Postgraduate level)	1	16	10

Adapted from (Rodić and Sah, 2005).

According to the Chinese respondents, specialists in environmental systems analysis and management are lacking in China. Current economic growth, combined with the magnitude and interrelatedness of the problems present, requires specialists with a systemic, 'helicopter view'. Deterioration of environmental quality, damage to the ecological systems as well as public health have only been seen in light of their adverse effects on economic development and social stability rather than issues deserving attention in their own right.

Weaknesses in curriculum

Respondents were asked to identify possible weaknesses in the current curriculum of Masters education programmes in water and sanitation, considering the present needs in their respective countries. Although the responses are quite similar in all four countries, there are some interesting differences, thus the results are presented per country.

As weaknesses, respondents in Bangladesh identified outdated courses that do not reflect developments in technologies and management approaches available (including low-cost ones as well). Teaching materials do not include critical assessment into situations where the application of particular technologies is most appropriate. The importance of consideration of local conditions is insufficiently imparted to students; local conditions are insufficiently highlighted and discussed. Similarly, field visits are insufficiently included in the curriculum. Finally, the research undertaken does not focus enough on technologies that would be suitable under the conditions prevailing in the country.

Chinese respondents also pointed out that course materials are not updated with latest developments and (international) research findings. As an additional – and important – weakness they identified lack of courses on management topics. Furthermore, universities are seen as somewhat isolated from society, industry and business, thus lacking practice-oriented courses.

Indian respondents were divided in their views on whether there are weaknesses in curriculum. Those who said that there are weaknesses, pointed that introductory subjects are often taught in a way that is not adjusted to the engineering discipline where they are to be applied (e.g., application of sanitary chemistry in design of treatment processes; interpretation of water quality parameters in relation to the requirements of design of treatment processes). In addition, curriculum seldom contains a separate subject on (legal aspects of) pollution monitoring and control.

In their answers, Nepalese respondents implied that, due to limited capacities in the country, they actually rely on foreign institutions for education of the engineers at Master's level. Those foreign institutions include various universities in India, Asian Institute of Technology, Thailand, Loughborough University, UK, and UNESCO-IHE Institute for Water Education, the Netherlands. Respondents expressed a view that curricula of foreign educational institutions do not always accommodate the specific needs of the country. As far as local universities are concerned, they are poorly attuned to the needs. Local realities are not taken into account; traditional indigenous knowledge is not deployed. Curriculum development seems to be guided by a preference for a particular technology, rather than by a quest to solve the problems at hand. Engineering education is not applied in its nature, the link between academia and industries is weak. There is too little research in general. Furthermore, the existing research is not oriented towards real-life problems in the country.

Respondents in all four countries mentioned the same factors causing and/or contributing to the current situation. These can be roughly clustered in two parts: insufficient financial resources and lack of co-operation. In addition to these two clusters, Chinese respondents cited lack of flexibility in the curriculum that does not allow for swift updates and changes.

As a consequence of the lack of financial resources, physical facilities and equipment are inadequate and universities are not able to attract qualified/experienced teaching staff. Systems for assessment and regular upgrading of educational programmes, teaching skills and methodologies are often lacking. In Nepal, universities do not even have resources to carry out regular thesis research studies.

Lack of co-operation and co-ordination between academia and organisations in the engineering field of water supply and sanitation were mentioned in all four countries. In addition, respondents in all four countries cited a lack of international co-operation among institutions of tertiary education. Chinese and Indian respondents were more interested in joint *research* with outstanding foreign universities as a type of co-operation, rather than *curriculum* development. They also added that such a co-operation is lacking among the universities *within* their respective countries as well.

As an illustration of the human resources available at institutions of tertiary education, Table 4 gives an overview of staff at selected institutions.

The universities listed are among the oldest and highly reputed education institutions in their respective countries. These figures are expected to be lower and thus less impressive for other universities.

The situation in Nepal is alarming - only 11% of the IoE staff have a Masters degree. This figure is representative of

Table 4. Composition of human resources by educational level at selected educational institutions

Institution	MSc (%)	BSc (%)	Other grad. (%)
BUET Dhaka, Bangladesh	60	10	30
Hohai University Nanjing, China	40	40	20
Anna University Chennai, India	67	17	16
IOE Pulchowk, Nepal	11	n.a.	n.a.

n.a. – data not available.

the general situation at educational institutions in Nepal. Generally, engineering professionals are not interested in teaching profession, due to low remuneration.

Only respondents in India and Nepal were able to cite strategies being implemented by various stakeholders to cater for additional professionals in their countries. Additional educational institutions are being established, efforts are made to increase the intake capacity at Masters level. Central Governments have (had) schemes in place to educate more engineers in the water supply and sanitation field. Public sector organisations encourage their staff to pursue tertiary level studies; there are special on-the-job training facilities provided; Master degree is introduced as a criterion in career development for public sector employees. For example, Indian Ministry of Urban Development enables annually some 90 professionals to attend post-graduate education in Public Health Engineering or Environmental Engineering at 11 academic institutions in India. In Nepal in order to increase human resources, Department of Water Supply and Sewerage (DWSS) in Nepal has helped to run a Master programme at IoE with WHO support since 1997; 60 engineers have been trained to Master level in six years.

Conclusions

Preceded only by political will and water resources, lack of institutional capacity is one of the main hindering factors for the achievement of the MDG targets on water supply and sanitation in Asia. In China, India and Nepal, efforts and activities in this field are fragmented and dispersed among various organisations and agencies involved, including NGOs and CBOs. Roles and responsibilities are not clearly defined.

In Bangladesh, lack of engineers and other professionals is cited among the top three obstacles to achieve the MDG targets. Lack of other professionals is identified among top three hindering factors in Nepal. 'Other professionals' include those with knowledge and skills to successfully address social issues, e.g. community participation and awareness-raising.

The results are inconclusive as to whether there are sufficient engineers in China and India to achieve the MDG targets.

Due to poor financial incentives and lack of professional opportunities in the water supply and sanitation sector in the sample countries, there is a significant loss of professionals to other sectors, mainly information and communication technology, and to the North. This loss ranges from estimated 10% for professionals with a Master degree to up to 40% for undergraduate students.

As the common weakness of tertiary education provided in all four countries, respondents cited the discrepancy between educational material (teaching curricula and research) and field of practical application of this material. Materials are often outdated regarding technological solutions available. Content is not oriented towards tackling real-life problems. Furthermore, materials do not take into account local societal realities where various technologies are to be implemented, thus poorly prepare engineers for their future practice. Collaboration with other professionals, such as sociologists, is not imparted to students, even though input from these specialists is considered indispensable for a sustainable success of water supply and sanitation projects. Engineering education also lacks courses on non-technological topics such as management and legal framework.

Lack of financial resources, accompanied by the consequent lack of physical facilities and qualified staff, is one of the main causes of the difficult situation at universities. Respondents also pointed out insufficient networking and exchange with other universities, nationally in large countries such as India and China, and internationally in all four sample countries.

Respondents in this study were very co-operative and willing to share their experiences and opinions. The choice of the method of individual interviews in person proved to be the appropriate one.

Recommendations

Fragmentation of water supply and sanitation related activities among various organisations and agencies involved wastes resources should be addressed at the highest level.

Engineering education on water supply and sanitation should be embedded in the societal context. Curricula should include all the aspects related to the issue, rather than technological ones only. Functioning in interdisciplinary teams should be imparted and encouraged. Field visits and practical exercises should be incorporated, in order to allow future Masters of Science to understand complexity of the problems in day-to-day practice.

A systemic approach should be pursued of integrated environmental resources management. A shift is necessary from technology oriented education to resource conservation and social dimension.

Educational institutions should be invited and *should take initiative themselves* to co-operate with other stakeholders in water supply and sanitation and with other educational institutions.

Adequate political attention should be given to the educational institutions to enable them to fulfil this more complex and more responsible role in contributing to the development of their countries. Political attention should be substantiated by significant financial support.

Human resources needed to achieve the MDG targets on water supply and sanitation could be best estimated on the basis of a comparative analysis of concrete projects with a proven sustainability record and those that failed. At that, distinction should be made between urban and rural areas, as they may require different professional input.

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Disclaimer

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References

Anonymous (1990), *New Delhi Statement,* Water Supply and Sanitation Collaborative Council. Geneva.

Bogardi, J. and Hartvelt, F. (Eds.) (2000), *Towards a strategy on human capacity building for integrated water resources management and service delivery, Water-Education-Training,* UNDP, World Bank Institute, UNESCO, UN University, IHE-Delft.

Foddy, W. (1993), *Constructing Questions for Interviews and Questionnaires: Theory and Practice in Social Research.* Cambridge Univ. Press: Cambridge.

Forbes, N. (2003), "Higher Education, Scientific Research and Industrial Competitiveness: Reflections on Priorities for India", *Conference on India's Economic Reforms,* 5 – 7th June, 2003. Stanford University.

Genesis Technology Group. 2003, *The Water Crisis in China.*

Halder, J. (2002), *A Silent Social Awakening,* NGO Forum for Drinking Water Supply and Sanitation. Dhaka.

Mazumdar, K. (2001), Rural drinking water supply in India - a critical review, *Journal of Indian Water Works Association,* Vol 33, No 3, pp. 211-218.

Mejia-Velez, D.F. and Rodić, Lj. (2005), "Higher Education in Water and Sanitation: a Preliminary Needs Assessment for the Achievement of the Millennium Development Goals in Latin America", *International IWA Conference AGUA 2005, From Local Action to Global Targets,* 31 Oct. – 4 Nov. 2005. Cali, Colombia.

Reviere, R., Berkowitz, S., Carter, C.C. and Graves- Ferguson, C. (eds.) (1996), *Needs Assessment: A Creative and Practical Guide for Social Scientists,* Taylor & Francis: Washington.

Rodić, Ljiljana and Sah, Ram Deep (2005), "Professional Capacity Needs Assessment for Millennium Development Goal on Water Supply and Sanitation in Asia", *XII World Water Congress of IWRA – Water for Sustainable Development. Towards Innovative Solutions,* 22–25 November 2005, New Delhi, India

Seckler, D., Barker, R, and Amarasinghe, U. 1999, Water scarcity in the twenty-first century. *International Journal of Water Resources Development,* Vol 15 No 1-2, pp. 29 – 42.

Shukla, S.R. (1999), Urban water sector - beyond 2000 AD, *Journal of Indian Water Works Association,* Vol 31, No 3, pp. 176-174.

UN (2000), *Millennium Declaration,* A/RES/55/2. 18 September. New York.

UN Millennium Project (2005a), *Health, dignity and development: what will it take?* Task Force on Water and Sanitation.

UN Millennium Project (2005b), *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals,* New York.

UN Millennium Project (2005c), *Preparing National Strategies to Achieve the Millennium Development Goals. A Handbook.*

UNDP (1998), *Capacity Assessment and Development in a Systems and Strategic Management Context,* Technical Advisory Paper No.3. New York.

World Bank (1990), *FY 90 Sector Review Water Supply and Sanitation, Infrastructure and Urban Development Department,* The World Bank/IBRD, Washington, D.C.

WSSCC (2004), *Resource Pack on the Water and Sanitation - Millennium Development Goals,* Water Supply and Sanitation Collaborative Council. Geneva.

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