MDG Needs Assessment Tools

Water and Sanitation Needs Assessment Model
USER GUIDE

DRAFT v. 1.0
24 July 2005

This User Guide is designed to be used in conjunction with the Water and Sanitation Needs Assessment model available at

http://www.unmillenniumproject.org/policy/index.htm

This User Guide was prepared by Alice Wiemers
Comments and suggestions are welcome and should be sent to the author at alice.wiemers@unmillenniumproject.org

TABLE OF CONTENTS

I. NEEDS ASSESSMENT OVERVIEW

This user guide is a step-by-step introduction to the UN Millennium Project's water and sanitation needs assessment tool. It assumes that users have read the Handbook[1] and have a basic familiarity with the fundamentals of an MDG Needs Assessment, but does not presume any prior technical knowledge of MDG needs assessment tools. The guide should be used concurrently with the water and sanitation needs assessment tool, available at www.unmillenniumproject.org/policy . In conjunction with the Handbook, it aims to help users embark on an MDG-based water and sanitation needs assessment.

Based on data input by the user, the water and sanitation needs assessment tool estimates the associated costs to support water and sanitation interventions as part of a strategy for meeting the MDGs at the national level. These estimates, along with estimates from other thematic areas (education, gender, rural and urban development, etc.) will help provide the basis for a national investment strategy for meeting the Millennium Development Goals.

MDG Needs Assessments

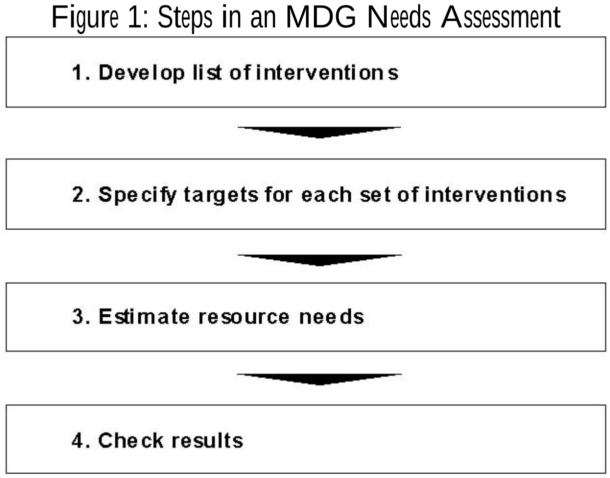
MDG needs assessments are the analytical building blocks for developing MDG-based poverty reduction strategies. They aim at helping governments to answer the question, "What investments will it take to meet the MDGs by 2015?" This approach marks a fundamental shift from current practice to strategy design, which asks the question: "How can governments best allocate existing resources?" Traditional sectoral work is thus based on forming annual budget allocations in a resource-constrained setting. An MDG Needs Assessment aims instead to help countries identify what resources are needed each year over a 10-year period to meet the MDGs by 2015. The resulting estimates can then be core inputs to an MDG investment strategy, including sequencing and capacity building, which, along with a policy and implementation outline, comprise a 10-year framework for meeting the MDGs.

The Handbook specifies an approach to creating an MDG-based PRS, and describes in detail the steps required to conduct an MDG needs assessment. This introduction will briefly outline these steps, and the role that the water and sanitation model play in the overall MDG needs assessment process.

First and foremost, the MDGs need to be interpreted at the country level. This entails defining quantitative outcome targets that are meaningful at the national level, and defining the areas of intervention that are needed to meet each of the MDGs. For water and sanitation, the MDG target aims to halve the proportion of people without sustainable access to safe drinking water by 2015, but countries may wish to alter the target – for example, by aiming to achieve it before 2015. Once outcome targets have been set, there are four steps in conducting a needs assessment, illustrated in Figure 1 and described below.

[1] UN Millennium Project. Forthcoming 2005. *Preparing MDG-Based Poverty Reduction Strategies: A Handbook of Best Practice.*

Figure 1: Steps in an MDG Needs Assessment



1 – Develop list of interventions

Users first need to define the critical interventions required to meet the MDGs. As outlined in the Handbook, interventions are defined broadly here as goods, services and infrastructure that need to be provided to generate outcomes. For water and sanitation, interventions include, for example, behavior change program. The UN Millennium Project recommends that thematic working groups be organized as part of the MDG-based planning process. These groups will help to guide the selection of a comprehensive set of interventions that comprise each investment cluster [see Step 2 of the Handbook]. In many cases countries will have already elaborated such interventions in their national and sectoral planning documents. These documents should be a starting place for defining MDG interventions. The UN Millennium Project has drawn up sample lists of interventions to reach the MDGs that can also be an input into thematic working group discussions. This list will then have to be modified and adapted to national needs. The water and sanitation interventions from these lists are the basis of the interventions outlined in this model.

2 – Specify targets for each set of interventions

Once national outcome targets have been set and interventions have been identified, countries need to determine who the interventions should reach, what proportion of this population will need to be covered by 2015, and how many units of each intervention are needed to reach them. This requires setting targets for each intervention and input quantity ratios that relate interventions to the people they reach.

Where relevant, targets and their corresponding interventions can be disaggregated by age and gender as well as by urban and rural areas. For example, urban and rural areas often require distinct interventions and technologies or face very different unit costs.[2] Disaggregation by gender and age will help countries better target services to populations in need and to adjust their service delivery to a changing demographic profile. You will find advice on using the models to reflect additional disaggregation in Part Four of this guide: Adapting the Model.

[2] A clear distinction between urban and rural needs is particularly warranted for the following categories: water supply and sanitation, transport infrastructure and energy services.

3 - Estimate resource needs

The next step is to estimate the financial, human and other resources needed to achieve the identified targets. The UN Millennium Project's water and sanitation model is designed to assist countries in making these estimates. This Excel-based needs assessment tool integrates the information input by the user to generate these estimates. It uses outcome targets, coverage targets and ratios, and unit costs to develop aggregate as well as intervention-by-intervention estimates of resource requirements. Similarly, simple ratios between beneficiaries, HR parameters, and infrastructure yield the non-monetary results. A simple ten-year scale up path allows users to map out the yearly investments needed to meet 2015 targets. The model aims to be transparent and adaptable to national needs. This user guide focuses largely on explaining how to use and adapt this model.

4 - Check Results

With any needs assessment, the results should be carefully reviewed to make sure that they are accurate and adequate to reach the MDGs. While every country will obtain different results based on local circumstances, the UN Millennium Project has carried out preliminary needs assessments in several countries that can serve as a basis for comparison. These results provide some guidance on the order of magnitude of the costs for reaching the MDGs in a subset of low-income countries. See the Handbook for sample results across areas and countries.

The water and sanitation needs assessment is part of a broad MDG strategy that covers all investment areas. Once needs assessments are completed for all investment clusters, they need to be aggregated and integrated as a first step in creating a ten-year MDG framework. As part of this consolidation process, countries should produce one summary budget outlining the projected expenditures for meeting the MDGs. In practice, this means that each model should contain a summary output page that can be easily summed and manipulated across clusters. This model has three types of summaries. The first, “Summary” sheet that presents yearly results in a reader-friendly format. The second, “Results Presentation” sheet presents a summary of the 2005, 2010, and 2015 costs in total and per-capita terms, as well as totals and averages over the period. The third, “Results Transfer” sheet is formatted for incorporation in the UN Millennium Project’s “financing model”.[3]

This user guide is designed to explain the use of the needs assessment tool as clearly and simply as possible. As you work through it, please feel free to contact the UN Millennium Project with any comments, questions, or suggestions for improvement. We look forward to hearing from you and wish you good luck in the needs assessment process.

[3] In addition to aggregation, this model allows countries to calculate the investments that can be financed by households and domestic government, and the remaining needs that will have to be financed by other sources such as ODA.

II. WATER AND SANITATION MODEL BASICS

Objective

The objective of the Water and Sanitation model is to estimate the resources required for a country to achieve Millennium Development Target #10: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation, as well as the interventions in water and sanitation needed to meet other MDGs (such as the health and environmental MDGs). The model identifies the interventions needed to scale up access to safe water and basic sanitation meet the target by 2015, and costs the associated resource requirements from the bottom up.

Scope

Millennium Development Target #10 calls for countries to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation (based on 1990 levels). To reflect the different areas of intervention needed to meet target 10, this model includes interventions in the categories of water supply, basic sanitation, wastewater treatment, and hygiene education. This model is a total cost model, meaning that it calculates the resources needed to reach the entire target population, including the recurrent costs of interventions for the population that currently has access to safe water and basic sanitation.

Water supply interventions bring safe drinking water to users by the extension, rehabilitation, and operation of technologies that are deemed “MDG compatible” in the national context. The general list of technologies to be adapted to country needs includes household connections, public stand posts, boreholes with handpumps, rainwater collection, and protected dug wells. The model allows you to define the acceptable types of water supply technologies, and the specific mix of technologies that will satisfy MDG needs in different areas of the country. It includes interventions in construction, rehabilitation, and operations.

Particular attention should be paid to the different technology needs of urban and rural areas. Any strategy for improving access to water supply must differentiate between urban and rural areas since communities’ needs and appropriate technology options will differ. For example, since wells are often more difficult to operate and less hygienic in dense urban settlements, to address urban water supply a greater emphasis needs to be placed on household connections and standpipes. Meanwhile, groundwater remains underutilized as a resource for drinking water supply in many rural parts of Africa. It can be tapped through investments in wells and boreholes.

The choice of the appropriate water supply system depends on factors such as community preferences, population density, cost, remoteness, and the local geohydrological profile. Experience over the past two decades amply demonstrates that communities need to be aware of the technical choices they need to make and their implications for use and maintenance of water supply systems (e.g. Black 1998). Where technically and economically feasible, household connections are preferable because they facilitate the application of lifeline tariffs or other tariff schemes for water supply that are important to help close the revenue cycle of water providers.

Many existing water supply systems are defective or do not function at all. In particular, existing boreholes in rural areas are often in need of major rehabilitation or upgrading. In large cities across Africa high rates of water leakage leave 39 percent of water unaccounted for (WHO and UNICEF 2000a). In such instances local authorities need to invest in the gradual rehabilitation of water supply systems with a particular focus on repairing leaking pipes, joints and valves; preventing the overflow of water reservoirs; and containing illegal water connections.

It is often assumed that once adequate infrastructure has been put in place communities can finance the operating costs of water supply schemes. This is not always the case, particularly in poor urban areas and rural regions with low groundwater tables. In all cases it is important to allocate adequate human and financial resources to the operation and maintenance of water supply and sanitation infrastructure. Annual O&M needs may amount to as much as 5-10 percent of the initial capital cost.

Basic Sanitation

Sanitation interventions follow the same logic as water supply interventions, focusing on the extension, rehabilitation, and operation of the sanitation technologies that will allow the country to reach Target 10. The UN Millennium Project Task Force on Water and Sanitation defines access to improved sanitation as “the access to, and use of, a facility for excreta and sullage[4] disposal that provides privacy while at the same time ensuring a clean and healthful living environment both at home and in the immediate neighborhood of users.” The general list of technologies to be adapted to country needs includes conventional sewerage, simplified sewerage, septic tanks, pour flush toilets or latrines, VIPs, and improved pit latrines (two pit).

Sanitation systems can be broadly separated into two categories. First are networked sewered technologies that rely on a centralized trunk infrastructure combined with off-site waste disposal. Here, this includes conventional and simplified sewerage[5]. Second are decentralized systems, such as improved singe pit latrines, ventilated improved pit latrines (VIP), pour flush toilets or septic tanks (c.f. WHO and UNICEF 2000a).

As with water supply technologies, a distinction between rural and urban needs is usually necessary. In densely populated urban areas a greater need exists for networked sanitation systems, which tend to be more expensive. Rural sanitation technologies usually consist of decentralized systems. Again, the choice of system depends on local characteristics and preferences. As with water systems, it is important to allocate proper human and financial resources to the operation and maintenance of sanitation infrastructure, including the regular emptying of pit latrines and other decentralized sanitation systems. Annual O&M requirements can amount to 5-10 percent of the initial capital cost.

[4] Defined as domestic sewage resulting from bathing and the washing of dishes and clothes in house.

[5] Sewerage systems using a simplified design standard, but with the same functionalities as traditional sewerage (e.g. condominial design used in countries like Bolivia and Brazil)

Wastewater infrastructure is needed to support use of sewered technologies.

The definition of basic sanitation does not yet include the treatment of sewage from public sewerage systems. However, traditional and simplified sewerage systems require safe disposal of the excreta away from the neighborhood. In large and high-density cities treatment of the effluent wastewater may be necessary. Likewise, wastewater treatment may be required to minimize nutrient loads carried into fragile freshwater ecosystems, such as small or shallow lakes, which may otherwise be subjected to eutrophication. While sewerage and wastewater treatment will not be required in all situations, in some cases public investments may be justified on economic, environmental and public health grounds. Therefore, wastewater treatment interventions are included in this model as part of the package of water and sanitation interventions that may be required to meet the full set of MDGs.

Options for wastewater treatment can be broadly separated into primary, secondary and tertiary treatment. In the first case all forms of settleable and suspended solids are removed through simple sedimentation processes or other means, while the second adds biological treatment of the effluent. Tertiary treatment removes chemical pollutants like phosphates, nitrates, and volatile odor-causing substances from the water. In many instances – particularly in warmer climates – cost effective solutions, such as waste stabilization ponds, exist that combine primary and secondary treatment. However, they require a lot of open space, which may be in short supply in urban areas. Where available space is a constraint or if industrial effluents need to be treated, more advanced treatment plants may need to be considered. Their high capital and operating cost can add substantially to the cost of meeting the water and sanitation, as well as environmental sustainability targets in urban areas.

Hygiene and Education

We emphasize the critical importance of providing hygiene education in conjunction with water and sanitation infrastructure . Only by ending unhygienic sanitation practices, such as open defecation and improper disposal of excreta, can the full health benefits of improved water supply and sanitation be achieved (e.g. Pruess et al. 2002, Curtis and Cairncross 2000). In many instances the largest health improvements can be generated through targeted hygiene education promoting hand washing with soap (Kotloff et al 1999) and proper on-site water storage to prevent microbial contamination.

Public education and awareness programs can take a number of forms, including community workers, mass media campaigns, formal integration of water and hygiene education into school curricula, and so forth. The best approach typically comprises a mix of these interventions and will be time and context specific (Waterlines 2004, UNICEF 1999). Experience from around the world shows that it typically takes a long time – sometimes up to five years – for behavior change programs to have an impact. For this reason it is necessary to implement long-term programs that systematically target the entire population in need.

Included in this model are interventions for behavior change programs accompanying rollout of sanitation infrastructure, hygiene education at primary schools, and country-wide mass media campaigns.

Limitations of the model. This model provides a framework for modeling direct costs of achieving a 50% reduction in the number of people without access to safe water and basic sanitation and for the water and sanitation related interventions needed to meet other MDGs. However, several water and sanitation related investments that countries may wish to consider are not included in the general UN Millennium Project water and sanitation model.

The first additional interventions that countries may wish to include are larger-scale interventions in water resources infrastructure and management. These may be needed to meet Target 10 and to align national water and sanitation strategies with the goal of environmental sustainability. Countries' needs for improving water resources infrastructure and management vary tremendously across countries and therefore cannot be analyzed using a standardized investment model. As part of their needs assessments countries may identify what needs to be done to update and/or develop new water resources management plans as well as additional water storage capacity to be built to improve water resources infrastructure and management to promote hydropower development, flood and drought management, and control of desertification. Corresponding investment needs are highly site specific and would need to be evaluated on a case-by-case basis. Similarly investments in irrigation and other infrastructure to improve water management for agriculture are best quantified through detailed project studies. Some suggestions for including water resources infrastructure and management interventions are provided in Part Four of this user guide: Adapting the model.

In addition, countries may need to include interventions to improve water quality. While the MDG Target does not set quality standards for drinking water, it is clear that surface and in some instances groundwater resources in several African countries are too polluted for human consumption without prior treatment (Showers 2002). According to the Global Water Supply and Sanitation Assessment Report over 35 percent of urban water supply violates national standards with regards to microbiological, chemical, physical or aesthetic characteristics (WHO and UNICEF 2000a) Where possible, communities should use water sources that do not require treatment, such as groundwater, even if initial capital costs may be higher. The lower operating costs and reduced need for maintenance will often exceed differences in capital costs. Where treatment becomes necessary, several technology options become available. They include settlement tanks, roughing filters, slow sand filters, artificial groundwater recharge, and chemical treatment of drinking water.

Users may also note that interventions for hospitals, health centers, and schools are not included in this model. These interventions fall into the category of interventions that could easily fall into several different investment areas. The UN Millennium Project has included these interventions in the education and health resource estimation models, because they will most often be implemented as part of the education and health strategies. Countries should make sure that these investments, like other "cross sectoral" interventions, are included in one of the resource estimation models used for a complete MDG needs assessment.

Data Requirements

The education model will require users to supply a number of data inputs and parameters. These inputs fall into five basic categories: demographic data, outcome and coverage targets, input quantity ratios, and unit costs.

- Demographic data are needed to establish basic population parameters. Required inputs include population size, average household size, and number of students in primary school. This data are typically found in national population censuses and statistical databases. The user should include this information for the "zone" covered in the model (for example, rural or urban population). Advice for disaggregating by zones is in Part Four of this user guide: Adapting the model.
- Outcome targets define the outcome objectives of the model. In other words, they represent the state of the world the model is trying to achieve. In the case of water and sanitation, these outcome objectives include reducing by 50% the proportion of the population without access to safe drinking water and by 50% the population without access to basic

sanitation (based on 1990 levels).

- Coverage targets define the proportion of the population that will be reached by a given intervention as part of a package of interventions needed to meet outcome targets. For water supply and basic sanitation interventions, the coverage targets for each type of technology will add up to the overall target of 50% gap reduction (such that each targeted household is reached by one type of technology). In addition, all existing infrastructure that is defective is assumed to be rehabilitated over the period (such that the percentage of defective infrastructure is assumed to go to zero by 2015). For wastewater and hygiene and education interventions, users define constant coverage parameters (such as % of primary school students receiving hygiene education, or % of existing sewerage connections newly fitted with wastewater treatment) according to national needs..

- Input quantity ratios define the relationship between beneficiaries and inputs., e.g. households served by one public standpost. They are necessary to calculate how many units of each intervention will be needed. In the water and sanitation model, input quantity ratios should be set at "best practice" levels (i.e. not to reflect current ratios of households to infrastructure). .

- Unit costs describe the cost of a single intervention. Some examples include the cost of installing a single septic tank, the cost of education one child in basic hygiene, or the cost of behavioral training accompanying the rollout of one piece of sanitation infrastructure.. These costs should be based on average unit costs for the selected intervention.[6] In some cases, costs are also calculated from other costs on a percentage basis, for example in the case of O&M or rehabilitation costs (given as % of capital costs) These data can be derived from a number of sources, including past procurement contracts or current market rates.

[6] Needs assessments could in theory use marginal costing to estimate resource requirements, but in practice this involves making quite demanding assumptions about the pattern of marginal costs, for which there is frequently insufficient empirical evidence. We account for differential marginal costs in two ways. First, we permit disaggregation of target populations based on relative unit costs (e.g. urban needs can be modeled separately from rural needs). Second, the model includes specific interventions that target hard-to-reach populations, such as subsidies for girls' education.

Because the model deals in constant dollars, costs are treated as static, i.e. a household water connection costs as much in real terms in 2005 as it does in 2015.

KEY POINTS:

1. This model calculates the full cost of achieving Millennium Development Target 10.

2. The model covers water supply, sanitation, wastewater treatment, and hygiene and education, which are important components of achieving the MDGs.

3. Required inputs include demographic data, outcome and coverage targets, quality parameters (input quantity ratios and defectiveness ratios), and unit costs. These can be derived from research, the experience of well-performing countries, national statistics, and records from relevant line ministries.

III. USING THE WATER AND SANITATION MODEL

Modeling Methodology

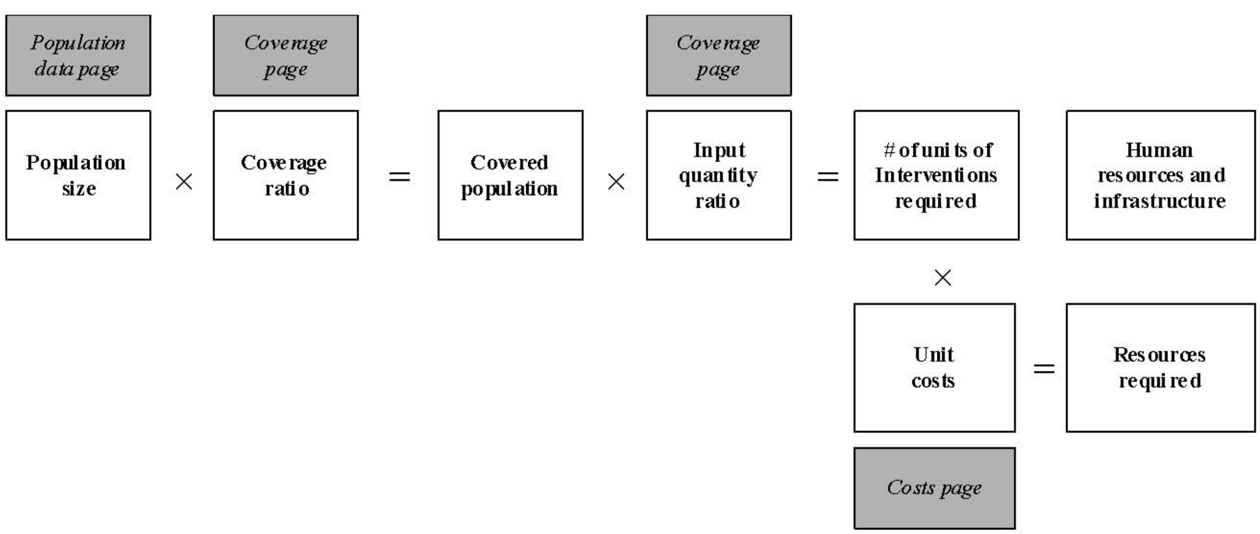
The model follows the general needs assessment methodology outlined in the Handbook. As you will remember, this methodology asks users to define the interventions that are required to meet the Millennium Development Goals, define targets associated with these interventions, and then determine the resources that will be required to implement them fully.

- Interventions are the specific inputs that are needed to deliver services effectively. They include water and sanitation infrastructure (including construction, rehabilitation, and operation of infrastructure), wastewater treatment (primary, secondary, and advanced treatment options) and hygiene and education activities (including behavioral change programs accompanying rollout, hygiene education in primary schools, and mass media campaigns).

- Outcome targets, coverage targets, input quantity ratios, and unit costs are all described above.

- Resource requirements are calculated using simple multiplication. For most interventions, the total population (or total number of households) is multiplied by coverage targets to get the population covered by a particular intervention, which is then multiplied or divided by input quantity ratios as appropriate to get the number of units required of each intervention. Finally, the required interventions are multiplied by unit costs, providing the total resource requirements for each year. For rehabilitation and wastewater treatment interventions, coverage parameters are multiplied by total number of units to determine the number of units requiring the interventions, and then multiplied by unit costs.

Methodology for calculating resource requirements



The Worksheets

Overview sheet

The Overview sheet provides a general overview to the model.

Interventions

The Interventions page allows the user to define interventions and associated intervention targets. The page is divided into four sections that correspond to the four general areas of water and sanitation interventions addressed by the model: water supply, basic sanitation, wastewater treatment, and hygiene and education. In each area, the Interventions page lists categories of specific interventions that form the basis of the needs assessment exercise.

The cells on this page are linked to relevant fields on the other worksheets, so changing intervention names on this page will change them throughout the model. We will return to this feature in Part Four: Adapting the Model.

Population Data

On this page, the user enters country-level population and demographic data. Required data include population size, average household size, and number of students in primary school. If the user wishes to calculate separate estimates for rural and urban areas (strongly suggested) or for other regional or demographic "zones", data should be entered for only one zone per model. See Part Four for more details on disaggregated assessments. Data need to be entered for the base year, and growth projections need to be made for subsequent years until 2015.

It is important that these data are as recent and as accurate as possible, and that growth projections are based on reasonable assumptions. These data underpin the entire costing model, so it is essential to verify their accuracy. Population data and projections can be obtained from national census data, as well as from the UN Population Division.

NB: When conducting needs assessments that cover more than one sector, users should check to make sure that the same population data are used across different models to ensure consistency of results.

Coverage

The Coverage section permits users to enter the coverage targets and input quantity ratios defining the reach of water and sanitation interventions. Coverage targets work similarly for water supply and basic sanitation interventions, so we illustrate their use with examples from sanitation. Coverage targets for wastewater and hygiene and education interventions are explained at the end of this segment.

Water supply and basic sanitation coverage targets are split into three sections: access statistics, type of infrastructure, and % of infrastructure that is defective.

T

Sanitation			
Access Statistics			
Access 1990	6%		
Access 2005-20015	19.00%	53.20%	
Type of Infrastructure (% of people covered)			
Conventional sewerage	0.0%	0.0%	
Simplified sewerage	1.9%	16.10%	
Septic tank	7.6%	11.00%	Sums to the "access 2005-2015" data above
Pour flush toilet or latrine	0.8%	5.10%	
VIP	0.0%	0.0%	
Improved pit latrine (Two Pit)	8.7%	21.00%	
Totals check--sums to access inputs above?	yes	yes	
% of infrastructure that is defective			
Conventional sewerage	20%	0%	
Simplified sewerage	20%	0%	
Septic tank	20%	0%	
Pour flush toilet or latrine	20%	0%	
VIP	0%	0%	
Improved pit latrine (Two Pit)	20%	0%	
# of hh using one unit			
Conventional sewerage	1		
Simplified sewerage	1		
Septic tank	1		
Pour flush toilet or latrine	1		
VIP	0		
Improved pit latrine (Two Pit)	1		

2015 targets. The "access" section calculates the overall percentage of the population that will need access to basic sanitation by 2015 to meet Target 10. Users enter data from 1990 and current 2005 levels. The 2015 column is filled in automatically, by halving the proportion of the population without access, based on 1990 levels. The difference between current levels and this target is how much the overall package of sanitation interventions will scale-up over the 10 year period.

T

each technology option. For the 2005 column, users should input the current percentage of households with access to each type of technology. These percentages should ADD UP to the "access 2005" data that you entered above[7]. In the 2015 target column, users define the levels of access to each technology—the "target intervention mix"—for which the water and sanitation strategy aims. These percentages should add up to the access target for 2015. For example, in the figure above there are 6 MDG compatible sanitation technologies defined. The current coverage of each—conventional sewerage at 0.0%, simplified sewerage at 1.9%, septic tanks at 7.6%, pour flush toilets at 0.8%, VIPs at 0.0%, and Improved Pit Latrines (Two Pit) at 8.7%—sum to the 2005 access figure of 19.0%. The target access figure, 53.2%, is divided into the access figures for each of the technologies—conventional sewerage at 0.0%, simplified sewerage at 16.10%, septic tanks at 11.0%, pour flush toilets at 5.10%, VIPs at 0.0%, and Improved Pit Latrines (Two Pit) at 21%. The line in red text, "Totals check—sums to access inputs above?" contains a formula to check that the technology breakdown adds up to the overall access percentage. Note that although each currently used technology is scaled up, the target intervention mix shifts the relative contribution of each to the overall access rates, focusing more heavily on simplified sewerage and pour flush toilets and less on septic tanks and improved pit latrines. Two technologies, conventional sewerage and VIPs, are not included in either mix, indicating that they were In the last section, "% of infrastructure that is defectiv

[7] This correspondence is by definition. Total access to water supply and sanitation technologies should be the combined percentages of people with access to technologies defined as "MDG-compatible"

e

model assumes that this proportion will decrease to zero over the period, such that all currently defective infrastructure is rehabilitated by 2015. Coverage inputs for wastewater treatment and for hyg

d

each line item. **Current** % of sewered connections fitted with wastewater treatmentPrimary treatm

Wastewater Treatment	
Current % of sewered connections fitted with wastewater treatment	
Primary treatment	0%
Secondary treatment	0%
Advanced treatment	0%
No treatment	100%
% of **new** sewered **connections fitted** with wastewater treatment Each year	
Primary treatment	50%
Secondary treatment	0%
Advanced treatment	0%
No treatment	50%
% of **existing** sewered connections **newly fitted** with treatment	
Primary treatment	20%
Secondary treatment	0%
Advanced treatment	0%
No treatment	80%

Hygiene and Education	
Hygiene education at primary education	
% primary students receiving hygiene education interventions each year	100.0%
Country-wide mass media campaigns	
Frequency of campaigns (per year)	1.5

o

secondary, and advanced). The next section specifies the proportion of new sewered connections that will be fitted with each level of wastewater treatment each year. These percentages will be combined with the coverage percentages for the sanitation technologies that require sewerage to calculate the number of new connections that will be fitted with treatment each year. For example, if this section indicates (as it does above) that 50% of new sewered connections will be fitted with primary wastewater treatment each year, then every year wastewater treatment interventions will be planned for exactly half of the sewered connections that are to be installed (i.e. if 100 households are to be fitted with conventional sewerage, then 50 households will also be fitted with primary wastewater treatment). In the third section, the user specifies the proportion of existing sewered connections that will be fitted with wastewater treatment by 2015. Combined with the information (entered above) on the current % of existing connections that have wastewater treatment, this will determine the scale-up of interventions to fit existing connections with treatment over the period. For example, if 5% of existing connections are currently fitted with wastewater treatment, and the user specifies that an additional 20% should be fitted over the period, then each year an additional 2% of the connections already present in 2005 will be fitted each year until 2015 (such that an additional 20% of existing connections are newly fitted over the 10 year period)Users specify percentage targets for primary, secondary, and advanced treatment. The remainder are assumed to not be fitted with treatment. For hygiene and education interventions, the user specifies o

b

campaigns to be undertaken per year. For the training designed to accompany the rollout of sanitation infrastructure,100% coverage is assumed, and thus needs no coverage target from the user (though cost data will be entered on the costs page).

Hygiene and Education	
Hygiene education at primary education	
% primary students receiving hygiene education interventions each year	100.0%
Country-wide mass media campaigns	
Frequency of campaigns (per year)	1.5

complete, m

How are targets derived?

Outcome targets are derived

an

addition, these interventions play an important part in meeting other MDGs, such as those for health and the environment. Coverage targets are based on na

n

wastewater treatment is an important intervention for economic, health, and environmental

reasons, but it may be the case that only a subset of sewered connections require wastewater treatment. In this case a coverage target significantly less than 100% may be warranted. Input quantity ratio targets are determined on the basis of evidence from well-perform
w
should be using one unit of a particular technology. While input ratios will naturally differ from country to country according to variations in local circumstances, there is a general rule of thumb: all targets should be derived from the existing evidence base and the government's best available understanding of what it will take to achieve the MDGs. In turn, this implies an inclusive and participatory national process that will enable stakeholders from various groups to contribute their expertise and knowledge to the identification of targets and interventions. See Step One in the UN Millennium Project Handbook for more information on the process of target setting.
Co

The C
m
wastewater treatment, and hygiene and education. In each of these areas, costs are divided into one time (capital) and ongoing (recurrent) expenses. In this model, we provide illustrative costs; actual costs will naturally differ by country. Water Supply and Sanitation
W
using water supply interve
in
values entered in each category for each type of technology. In the "capital costs" section, users need to input the total cost of installing one unit of the particular technology. For example, the capital cost of a p
c
place. Since this model measures financial rather than economic costs, only the direct financial cost of installation should be included—in particular, this means that the costs should exclude any "sweat equity" put in by recipients who participation in installation. Per Technology Unit CostsCapital costehold Connection60$

Water Supply	
Per Technology Unit Costs	
Capital cost	
Household Connection	$ 600.0
Public stand post	$ 1,200.0
Boreholes with handpumps	$ 300.0
Rainwater collection	$ 25.0
Protected dug wells	$ 40.0
Annual O&M cost (% of capital cost)	
Household Connection	7.5%
Public stand post	7.5%
Boreholes with handpumps	7.5%
Rainwater collection	5.0%
Protected dug wells	3.0%
Cost of rehabilitating (% of capital cost)	
Household Connection	20.0%
Public stand post	20.0%
Boreholes with handpumps	20.0%
Rainwater collection	50.0%
Protected dug wells	50.0%

p
In the "cost of rehabilitating" section, users input the costs associated with rehabilitation of existing infrastructure of each type that
p
Wastewater Treatment
U
fi
treatment infrastruct

treatment (i.e. recurrent or O&M costs). In this section, 0&M costs are entered as separate costs, rather than as a percentage of capital costs. Per unit capital costsPrimary treatment (Off-site simplified sewerage system: settlement tanks)

Wastewater Treatment	
Per unit capital costs	
Primary treatment (Off-site simplified sewerage system: settlement tanks)	$ 40.0
Secondary treatment: conventional sewerage	$ 180.0
Advanced treatment	$ 310.0
Per unit annual cost of treatment (O&M)	
Primary treatment	$ 2.0
Secondary treatment	$ 28.8
Advanced treatment	$ 14.3

to

programs to accomp

entered in $/unit of infrastructure installed. (Note that they are not entered this way and not per user served. For technologies that serve more than one household, for example, the per-unit training costs will cover the expense of training a whole group). The calculation of overall costs for these interventions is simply cost per unit x number of units installed. The second category of hygiene and education costs are the per-student costs of teaching hygiene at primary schools. The aggregate yearly cost of these interventions is calcu

u

population inputs page. The third category of cost is the per-campaign cost of mass media interventions. Cost of trainConventional sewerage

Hygiene and Education	
Cost of training behavior change program accompanying rollout ($/ unit)	
Conventional sewerage	$ 4.0
Simplified sewerage	$ 4.0
Septic tank	$ 4.0
Pour flush toilet or latrine	$ 4.0
VIP	$ 4.0
Improved pit latrine (Two Pit)	$ 4.0
Hygiene education at primary schools	
Cost of teacher training and logistical support ($ per student)	1.5
Country-wide mass media campaigns	
Cost of mass media campaign (000)	$ 900,000

O

T

check whether t

the user to input any n

should be entered in the underlying page (e.g. Cost, Coverage, or Population Data); this will automatically update the Organizing Data page. It is crucial to correct data in the underlying pages rather than in the Organizing Data page because the Resource Needs page draws all dat

u

pages, they will break the link between the Resource Needs page and the underlying data entry pages, making future changes and analysis more difficult and error-prone. Therefore, users should ensure that they use the Organizing Data page only to check the validity of their entries and make all changes on the underlying data input pages. Resource Needs

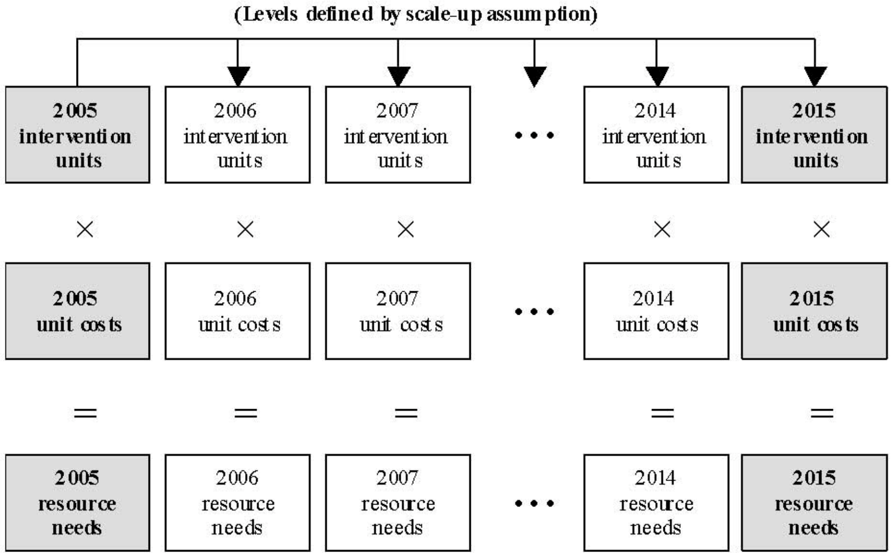
T

resources need

this page; t

(discussed below). The Resource Needs page takes the current coverage data and 2015 coverage targets and extrapolates a scale-up path between them to determine resource requirements for each year. The following figure demonstrates the basic approach of the Resource Needs calculator.

CALCULATING RESOURCE REQUIREMENTSCALCULATING RESOURCE REQUIREMENTS



T

may or may not vary with time) to determine annual resource requirements for each intervention. An important distinction to make is among the way total capital, total rehabilitation, and total O&M co

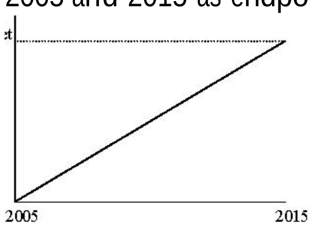
c

O&M costs accrue to the total stock of interventions delivered. Rehabilitation costs accrue only to the incremental defective infrastructure that is rehabilitated during the year. In the septic tank example below, total construction costs are calculated by multiplying the number of incremental units constructed each year by the unit construction cost. Recurrent (O&M) expenditures are calculated by multiplying the O&M unit cost by the total stock of septic tanks. Rehabilitation costs are calculated for only the incremental units rehabilitated during the year. *678910*Septic tank**20052006200720082009**Parameters# of zone 1 hh usiCoverage

1.00	1.00	1.00	1.00	1.00
7.60%	7.94%	8.28%	8.62%	8.96%
1,682,184	1,789,969	1,900,400	2,013,473	2,128,772
20%	16.9%	14%	12%	9%
336,437	302,793	269,149	235,506	201,862
1,345,747	1,487,176	1,631,251	1,777,967	1,926,910
	107,785	110,431	113,073	115,299
	33,644	33,644	33,644	33,644
50	50	50	50	50
25	25	25	25	25
4	4	4	4	4

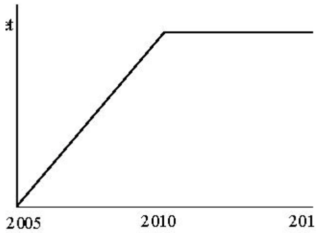
.

However, many different scale-up functions are feasible so long as they are increasing and use 2005 and 2015 as endpoints. MDG targetMDG targetMDG target



th

start out quickly to achieve rapid scale-up, then grow more slowly as 2015 approaches. Many other paths are possible. For example, countries may wish to frontload investments in some sanitation technologies because of their important health effects, implying a rapid scale-up in early years . If the country decides to set targets for some interventions that should be reached before 2015, then the scale-up path would be kinked. MDG target



The diagram below (which omits years 2007-11 for space reasons) illustrates how scale-up functions are used to derive year-by-year estimates for resource needs.

	Septic tank	2005	2006	2007	2013	2014	2015
201	Parameters						
202	# of zone 1 hh using one septic tank	1.00	1.00	1.00	1.00	1.00	1.00
203	Coverage						
204	% total zone 1 hh using septic tank (incl. defective infrastructure)	7.60%	7.94%	8.28%	10.32%	10.66%	11.00%
205	# total zone 1 septic tanks at year end (incl. defective)	1,682,184	1,789,969	1,900,400	2,618,867	2,748,952	2,878,345
206	% defective zone 1 septic tanks	20%	16.9%	14%	3%	1%	0%
207	# of defective zone 1 septic tanks at year end	336,437	302,793	269,149	67,287	33,644	0
208	# of effective zone 1 septic tanks at year end	1,345,747	1,487,176	1,631,251	2,551,579	2,715,308	2,878,345
209	Annual changes in coverage						
210	# new zone 1 septic tanks provided during year		107,785	110,431	126,446	130,085	129,393
211	# ineffective zone 1 septic tanks rehabilitated during year		33,644	33,644	33,644	33,644	33,644
212	Per Unit Costs						
213	Capital Cost ($ per unit)	50	50	50	50	50	50
214	Rehabilitation cost ($ per unit)	25	25	25	25	25	25
215	O&M cost ($ per unit per year)	4	4	4	4	4	4
216	Aggregate Cost						
217	Capital/construction costs	-	5,389,258	5,521,548	6,322,308	6,504,245	6,469,651
218	Rehabilitation costs	-	841,092	841,092	841,092	841,092	841,092
219	O&M costs	5,382,989	5,948,704	6,525,003	10,206,317	10,861,232	11,513,378
220	**Sub-total costs**	5,382,989	12,179,055	12,887,642	17,369,717	18,206,568	18,824,121

input quantity (line 202) to calculate the total number of septic tanks needed (including defective pieces). For 2006, line 207 applies the data on the proportion of existing infrastructure that is defective (line 206) to the total infrastructure quantity to calculate the starting quantity of defective septic tanks. This number is then "scaled down" to zero over the ten-year period. Line 208 then calculates (by simple subtraction) the number of effective tanks at the end of each year. The "annual changes in coverage" (lines 209-211) section calculates the incremental number of new tanks installed and the number of defective units rehabilitated during the year. The information on new units is combined with cost data for capital costs (line 213) to generate total capital cost estimates (line 217). The information on number of defective tanks rehabilitated is combined with the per-unit rehabilitation cost (line 214) to generate aggregate yearly rehabilitation estimates (line 218). O&M costs (line 215) are applied to the total number of existing units at the end of each year to generate aggregate O&M estimates (line 219). The subtotal of costs for septic tanks is aggregated in line 220. All of the input data has already been entered in the Cost, Coverage, and Population Data sheets. The only decision the user needs to make on the Resource Needs page is the cho

o

Which scale-up path should the user choose? The optimal scale-up path is the one that best reflects planners' strategies for s

th

sense for some interventions, but perhaps not for others. For example, planners might want to front-load the expansion of some priority interventions, with the result that 2015 targets are reached much sooner, perhaps as soon as 2010. Another front-loaded scale-up path might be one that increases rapidly in the first five years, then increase at a much slower rate in the last five years. By contrast, planners m

re

growth. Whatever the case, it is clear that planners will need to adapt scale-up paths to specific situations. The Resource Nee

se
At the bottom of the page, these sub-totals are aggregated into a summary table that calculates the aggregate sum of resources required. Summary Sheet

The Summary
information on total capi
supply, sanitation, wastewater treatment, and hygiene and education) for each year between 2005 and 2015. It also provides a 10-year average as well as per-capita cost calculations for total resource requirements. The Summary sheet works automatically and does not require inputs from the user. As discussed in the in
ag
to be entered directly into the UN Millennium Project's financing model alongside the outputs of other needs assessment models.

R

The Region Agg
as
in Part Four: Adapting the Model. KEY POINTS:

1. This model d
basic sanitation. The sheets of thi
ta"
assembles the list of interventions to be costed. "Coverage" allows users to set targets for the interventions. "Costs" is a sheet for all unit costs to be input.
3
sheet that tabularizes all of the data. "Resource Needs" calculates a scale-up path for resource requirements. The three summary pages, "Summary", "Results presentation", and "Results transfer" bring all of the calculations together into displays of aggregate capital, rehabilitation, and operating expenditures for each of the various areas for investment.

IV. ADAPTING THE MODEL

The water and sanitation model is designed to be generally applicable to a broad range of countries and systems, but countries may wish to adapt it further to local circumstances. Here, we discuss four adaptations that countries may wish to make to the model: dropping interventions, changing interventions, adding interventions, and adding regions.

Dropping interventions

In some cases, countries may wish not to use one or more of the interventions built into the model. For example, a country may decide that some of the particular technology interventions are not needed. There are many ways to reflect this in the model, but the easiest is to zero out coverage and costs. To do this, users enter zeros for all coverage targets associated with the intervention. This will eliminate the intervention from resource estimates. In the example below, for example, conventional sewerage has been eliminated.

40	Type of Infrastructure (% of people covered)		
41	Conventional sewerage	0.0%	0.0%
42	Simplified sewerage	1.9%	16.10%

Changing interventions

To modify an intervention by changing it to a different kind of intervention, users should go to the "Interventions" page and change the name of the intervention. Then, in each row where the intervention appears on the other worksheets (costs, coverage, resource needs), the user should alter the spreadsheet accordingly to reflect the costing of the intervention. If the costing methodology for the intervention remains the same as the one it is replacing, then changing the names of the cells in the "Interventions" page should be sufficient. Otherwise, the user will need to ensure that appropriate costing fields and formulas are entered for the new intervention.

Adding interventions

There are many ways to add interventions to the model, and advanced users should find it relatively easy to add rows and link them throughout the model to the relevant worksheets. The simplest, most modular, and most intuitive way to add an intervention to the model, however, is to add a worksheet to the model to account for all of the new interventions.

Users should enter any new population data, coverage targets, input quantity ratios, and unit costs associated with the new intervention. The new worksheet should follow the same general methodology as the rest of the model, scaling up coverage targets and multiplying them by unit costs to derive resource estimates. Once resource estimates have been calculated, formulas on the Summary page should be updated to include them. In particular, the formulas for capital, rehabilitation, O&M, and total costs should be revised to include the new intervention area. If the intervention falls into an existing category (water supply, sanitation, etc.), then the subtotals in that area should be altered as well.

One example of an intervention that users may wish to add is systemic costs, which are not currently included in the model because they are so country-specific. To add this set of interventions, users should create a new worksheet, then decide how best to estimate the costs of water storage interventions. There is no single right way to model these costs; instead, there are many plausible methods. Costs could be calculated for each planned facility, including capital and recurrent costs, and for rehabilitation of existing facilities. Users could also estimate water storage needs on a per-liter or per capita basis, using the yearly coverage estimates as inputs. Whatever method is chosen, it should disaggregate capital, rehabilitation, and O&M expenditures.

Adding regions

To calculate results for additional regions (e.g. provinces, or separate urban/rural models), the user should create one copy of the model for each region to be assessed. One of these copies should be designated a master copy. The master copy is used to aggregate investment needs across all of the regions. Each of the models should correspond to a single region and named accordingly (e.g. education_rural.xls, education_urban.xls).

In each model, the user should enter population data, coverage targets, input quantity ratios, and unit costs specific to the region. Each region's model will then generate an individual estimate of total resource needs.

Next, the user needs to add up the resource needs across regions. This is done in the master copy's Region Aggregator page, where the user should copy and paste "as values" the capital, recurrent and total costs for pre-primary, primary, secondary, and adult literacy into the corresponding line in the summary page.[8] It is important to paste "as values" so that the actual numerical values get pasted rather than formulas, avoiding broken links. The Region Aggregator page then helps the user calculate the total resource requirements across all regions.

NB: When working with multiple regions, the user will need to take special precautions to ensure that changes to the model architecture of one region are reflected appropriately in the others.

KEY POINTS:

1. Interventions can be dropped, changed, or added. Each of these operations is simple, but will require careful attention to make sure that adjustments are reflected accurately in worksheet calculations.
2. Regions can be added in order to permit users to create separate cost estimates for different parts of the country, e.g. rural vs. urban, or different sub-regions. These calculations can be aggregated by pasting them into the Region Aggregator page of the master copy

[8] The "Paste Special" is under the "Edit" menu. Choose the function of "paste as values" to transfer resource requirements from the region-specific models to the master copy.

V. CHECKING RESULTS AND TROUBLE-SHOOTING

Checking Results

Once the user has derived results from the needs assessment model, how can s/he tell whether the results are realistic?

One way is to check the per capita resource needs against other countries where needs assessments have been conducted. Results from five low-income countries can be found in Chapter 3 of the Millennium Project Handbook and on page 244 of Investing in Development. In general, these findings suggest that annual per capita expenditures for water and sanitation should fall within the range of $2-$6 in 2006 (rising to $6-$12 in 2015). Of course, the actual number will depend on how far away the country is from Target 10, the rural/urban population mix, the state of existing infrastructure, and the chosen target technology mix, etc; but this range provides a reasonably robust basis for comparison.

Other ways to check results include examining the path of per capita expenditures between 2006 and 2015 and running internal checks on cost drivers:

.

- Path of per capita expenditures. One way to check for major errors is to study the 2006-2015 path of per capita expenditures. If there are any unusual spikes or troughs, or other patterns, users may need to re-examine scale-up paths.

- Internal checks on cost drivers. Another way to assess results is to analyze the major drivers of total resource needs. UN Millennium Project analysis suggests that in countries with current rates of access to basic sanitation that are lower than those for access to water (as is the case in most low-income countries), sanitation and wastewater treatment costs make up roughly 30-40% of total costs in 2006, rising to 45-70% of total costs by 2015 (as coverage increases to meet the targets). Water supply interventions make up roughly 50-60% of the overall total in 2006, falling to 20-55% in 2015. Hygiene and education interventions make up about 10-15% of overall costs in 2006, falling to 5% in 2015 as overall costs rise. Cross-country comparisons also suggest that capital costs (including rehabilitation costs, which are one-time costs) typically account for between 30% and 50% of water supply costs and about 50% to 80% of sanitation and wastewater treatment costs, largely reflecting the higher initial coverage of water supply infrastructure. If the user finds large variances in one or more of these costs, s/he may wish to re-examine some of the unit costs, the outcome/coverage targets, or input quantity ratios and compare them to international standards to identify the source of variance.

Trouble-shooting

During the course of the needs assessment, users may also encounter a number of modeling issues and problems. Here, we discuss some of the most common and identify simple tools that may help resolve them.

Unrealistically high or low resource estimates

After comparing results to comparable estimates, the user may find that the model has produced unrealistically high or low values. A bit of detective work will be in order, moving from general to specific issues.

- Are any of the cost drivers significantly higher or lower than cross-country benchmarks?
- Are there any large spikes or troughs in the pattern of resource needs? (this might indicate a typographical error in a single year's entry).
- Are all of the coverage and input quantity ratio targets accurate?
- Are the unit costs reasonable?
- Are recurrent and capital costs calculated correctly? (if the calculations are mixed up, based incorrectly on incremental vs. total figures, results may be unrealistically high or low).
- Are results highly sensitive to small changes in variables? If so, users should be very careful in interpreting results.

#VALUE

If the phrase "#VALUE" appears in a cell, the problem is most likely that the user has entered an inappropriate value for the variable, e.g. text in a cell that only accepts numbers. If inappropriate values are entered into cells that are used to calculate values in other cells, all the dependent cells will also display the #VALUE symbol. If confronted with this problem, the user should click on a cell where the #VALUE symbol is displayed and go to the "Tools" menu, select "Auditing," and click on "Trace Precedents." By following the arrows backward to the cell with the original error, the user should be able to identify and correct the problem.

#REF

If the phrase "#REF" appears, a link has been broken, most likely by deleting a precedent cell. If the #REF symbol has just appeared, go to the "Edit" menu and select "Undo," which may bring back the deleted cell and solve the problem. If this does not help, select a cell where the #REF symbol appears and try to assess what cell might have been deleted or moved. If, for example, the cell is the sum of various infrastructure costs and there is one #REF symbol in the summation formula, it is likely that the missing cell is also an infrastructure entry. Going through this process may help the user identify and rectify the problem.

Many #REF problems can be avoided by following two simple rules. First, before deleting any cell, select it and use the Auditing function (under the "Tools" menu) to "Trace dependents." If there are any dependents, make sure that their formulas are appropriately modified before deleting the cell.

Second, when moving cells or rows from place to place, always CUT (from the "Edit" menu) and then PASTE (also from the "Edit" menu). Never "COPY" and paste. Cutting and pasting updates all of the links; copying and pasting does not.

#DIV/0!

The "#DIV/0" symbol means that a formula involves division where the denominator is zero, yielding an undefined result. When this occurs, examine the formula and check the precedent cells to ensure that the values are correct. More often than not, the "#DIV/0" symbol appears when an entry has been accidentally deleted and used as the denominator of in a quotient formula, yielding this readily resolvable problem.

KEY POINTS:

1. Results can be checked against assessments from other countries. A reasonable range for annual per capita investment needs is around $2-$6 in 2006, rising to $6-$12 in 2015.

2. There are a number of common spreadsheet mistakes that result in error messages. Using the "Trace Precedents" auditing function can help identify and resolve some problems. Proper Excel technique can help prevent others from occurring in the first place.

3. When results appear unrealistic, backtrack and check the accuracy and plausibility of assumptions and inputs; check for technical errors; and assess the overall sensitivity of the model to small changes in key variables.

VI. OTHER RESOURCES AND FURTHER READING

There are a number of different models and resources available to inform work on modeling education costs, and we encourage users to study and absorb as many of them as possible.

Models

On the UN Millennium Project web site, users will find copies of models completed by other country teams. In particular, the modeling tools developed by the Tajikistan team are useful to understand how different countries have adapted models to local systems and circumstances. The page for needs assessment tools can be located at the following URL: http://www.unmillenniumproject.org/policy/needs03.htm

Water and Sanitation Resources

Health, Dignity, and Development: What Will It Take? the report of the UN Millennium Project's

Task Force on Water and Sanitation, identifies technology choices and quality parameters from a variety of policy contexts that may be useful in determining input quantity ratios and other targets.

Needs Assessment and MDG-Based PRS Resources

The UN Millennium Project Handbook features extensive information on the process of developing MDG-based poverty reduction strategies, including needs assessments. In particular, Chapter 3 focuses on needs assessment tools and discusses education sector assessments in detail.

Investing in Development, the report of the UN Millennium Project to the UN Secretary-General, provides a general overview of MDG-based planning.