CHAPTER 4

ANALYSIS OF RESULTS

4.1 SITUATION IN 2000

4.1.1 Woodfuel deficit and poverty

4.1.1.1 Deficit areas

At national aggregated level, all countries presented positive balances between the estimated total consumption and the fraction of the total national increment of woody biomass available for energy use. However, these balances have little meaning because they hide important local variations and also because the access limitations due to physical aspects have yet to be determined.

The areas that present a more or less marked deficit in the local demand/supply balance, calculated for 9 x 9 pixel windows, cover some 14 percent of the cumulative country areas. The occurrence and distribution of deficit areas within the countries is uneven, as shown in Table 4. There are countries where deficit areas are relevant, such as Viet Nam and Cambodia, and others where these areas appear marginal (Lao PDR, China) or negligible (Malaysia).

TABLE 4

Areas in different woodfuel supply/demand balance categories by country (data for 2000)

	Percent of countries' land area under different balance conditions						
	High deficit	Medium-high deficit	Medium-low deficit	Balanced	Medium-low surplus	Medium-high surplus	High surplus
Cambodia	7.9	6.5	5.7	7.1	7.0	8.0	57.8
Yunnan (Prov. China)	1.7	2.6	3.6	3.2	10.9	17.2	60.7
Lao PDR	0.8	0.8	1.3	1.1	3.1	5.7	87.3
Malaysia	0.2	0.1	0.1	1.3	0.5	0.6	97.2
Myanmar	6.1	5.7	4.6	2.0	3.7	4.6	73.3
Thailand	4.0	5.1	9.2	10.0	15.8	13.7	42.1
Viet Nam	14.8	6.3	6.3	3.9	8.7	12.2	47.8
Aggregated totals	**5.0**	**4.2**	**4.8**	**4.2**	**7.5**	**9.1**	**65.3**

The most detailed spatial distribution of the various balance categories can be observed in Figure 27 (subregional overview) and in Figures 28 to 34 (individual country maps).

Aggregating pixel values by sub-national administrative units helps in identifying priority action areas for government attention (Figure 35).

4.1.1.2 Affected populations

The percentages of rural populations living in the various supply/demand balance categories are shown in Table 5. It is obvious, and expected, that densely populated areas, such as urban areas and rural settlements, present conditions of high deficit, since the balance is calculated within a limited distance, yet it is rather striking that, overall, almost half of the "sparse" rural population live in deficit areas. In countries like Cambodia, Viet Nam and Myanmar, virtually two-thirds of the entire rural population live in areas that present deficit conditions, i.e. there is not sufficient woody biomass available within a 5 km radius of their home.

Over 35 percent of all "sparse" rural dwellers live in areas presenting marked deficit conditions (medium-high to high deficit). In absolute numbers, this corresponds to some 45 million people, of which 27 million people live in high deficit and 18 million in medium-high deficit conditions.

This does not always necessarily imply that the entire population in these areas faces a real energy deficiency. Rather, it means that either these populations can afford marketed woodfuels or alternative fuels, or they are likely to suffer subsistence energy shortages. In this perspective, the links with poverty become very close. In such a situation, and without specific intervention, the poorer segments of the population are likely to suffer serious woodfuel shortages and consequent negative impacts on their nutrition and health conditions.

TABLE 5

Rural populations living in different woodfuel supply/demand balance categories in 2000

	Percentage of rural population (density below 2000 inh/km²)						
	High deficit	**Medium-high deficit**	**Medium-low deficit**	**Balanced**	**Medium-low surplus**	**Medium-high surplus**	**High surplus**
Cambodia	31.2	22.9	14.1	5.5	8.5	6.0	11.8
Yunnan (Prov. China)	5.8	7.9	9.0	6.7	17.2	18.4	35.0
Lao PDR	4.1	5.5	8.6	5.7	11.7	12.6	51.7
Malaysia	0.5	0.5	0.6	0.8	1.6	2.8	93.2
Myanmar	32.1	22.6	12.4	4.0	6.4	4.9	17.4
Thailand	12.3	14.7	19.6	11.2	17.2	9.8	15.2
Viet Nam	40.3	13.5	10.9	5.1	9.2	7.8	13.1
Total rural population	**21.4**	**14.3**	**12.8**	**6.6**	**11.7**	**9.2**	**24.1**

4.1.1.3 Woodfuel balance and poverty

The integration of supply/demand balance with poverty-related malnutrition indicators (Figures 35 to 37) permitted stratification of the population of the countries of the subregion into categories determined by the combination of the two factors. Results of this analysis, summarized in Table 6, showed that approximately one-quarter of the entire population of the subregion, i.e. some 66 million people, live concomitant conditions of poverty and woodfuel deficit (red and orange areas in the table), and almost one person in ten, i.e. some 25 million, live in conditions that can be considered very serious due to the interaction of the worse conditions under both perspectives (red area).

TABLE 6

SE Asia population distribution by woodfuel balance categories and malnutrition levels (percent)

Woodfuel supply/demand balance		Malnutrition (or vulnerability)							
		low	mid-low	mid-high	high	very high	critical		
		1	2	3	4	5	6	Total	
critical deficit	1	3.3	1.8					5.1	"very serious conditions" total 9.4
very high deficit	2	2.7	1.0	0.8	3.8	0.2		8.5	
high deficit	3	0.5	1.8	4.1	4.1	0.9	0.4	11.7	
medium deficit	4		1.4	2.5	2.3	1.9	0.5	8.6	"serious" total 15.3
light deficit	5	0.3	0.1	0.2	0.5	1.3	1.2	3.6	
balanced	6	0.5	0.6	0.8	1.7	0.2	0.4	4.2	
light surplus	7		0.6	0.1	0.7	0.2	0.5	2.2	"serious"+ "very serious" = 24.7
	8	0.1	1.5	0.5	2.4	0.6	2.1	7.2	
	9	0.2	0.7	2.3	2.2	5.5	5.0	15.9	
	10		2.7	5.0	4.4	2.4	8.4	22.8	
very high surplus	11		0.7	7.3	0.2	1.5	0.4	10.1	
		7.6	**12.9**	**23.6**	**22.3**	**14.8**	**18.9**	**100.0**	

The national-level analyses revealed considerable differences among the countries, as shown in the country-level tables in Annex 6, and summarized in Table 7 below.

Following the same definitions applied in Table 6, Cambodia and Viet Nam are the countries that appeared more vulnerable, with approximately one-quarter of the entire population in the "red" zone, and almost as many in the "orange" zone. Myanmar's situation appeared less critical, but nevertheless with a sizeable share of the population in deficit areas. All other countries presented only pockets of poverty and deficit conditions, either due to better nutritional parameters (Thailand) or biomass resources (Lao PDR, Malaysia, Yunnan).

TABLE 7

Country-level summary of population with malnutrition symptoms living in woodfuel deficit areas in 2000

	Population with critical malnutrition and high (percent) (A)	Population in less critical deficit and poverty areas (percent) (B)	Population presenting malnutrition symptoms living in woodfuel deficit areas (A+B)
Cambodia	25.3	18.7	44.0
Yunnan (China)		9.5	9.5
Lao PDR	6.8	5.3	12.1
Malaysia		6.8	6.8
Myanmar	7.9	20.2	28.0
Thailand		9.1	9.1
Viet Nam	22.8	23.0	45.8
Aggregated mean	**9.4**	**15.4**	**24.7**

4.2 WOOD ENERGY SCENARIOS IN 2015

4.2.1 National level balance

At aggregated national level, and assuming mean and maximum productivity variants, all countries present positive supply/demand balance in 2015, as shown in Annex 9.

However, it is important to emphasize that "supply" refers to "potentially available" quantities, since physical accessibility of biomass resources was not analysed in this study. The true accessible woody biomass for energy use is certainly less than the nominally available quantity, and therefore the surplus here estimated is more apparent than real.

The balance becomes negative or very close to zero in Cambodia, Thailand and Viet Nam for both consumption scenarios if minimum productivity levels are assumed. However, such low levels of productivity are possible at local levels, but unlikely as a general condition.

These aspects further support the consideration that wood energy systems are highly location specific and that aggregated values generally fail to convey the true situation of a country, which would include both surplus and deficit conditions that call for different policies and management solutions.

4.2.2 Main deficit areas and affected population in 2015

4.2.2.1 Deficit areas

The percent of country areas in different woodfuel balance categories for all consumption and supply scenarios are reported in Annex 9.

According to the most likely scenario, which assumes a general reduction in fuelwood consumption and a relative increase in charcoal consumption (GFPOS-trend scenario), and applying the mean productivity variant, some 13.9 percent of the subregional area will present a deficit condition in 2015, a share that is practically equal to that estimated for 2000 (14 percent). The only change appears to be an increase in the "moderate" categories (medium-level deficit and surplus) and a small decrease in the extreme categories (high deficit and surplus).

If a BAU scenario is considered, in which the per capita consumption is assumed constant, the overall deficit area increases to some 15.1 percent, with a significant increase in mainly the high-deficit category.

4.1.2.2 Populations by supply/demand balance categories in 2015

The percent of total and sparse rural populations living in different balance conditions for all consumption and supply scenarios are reported in Annex 9.

In the most likely scenario (GFPOS-trend + mean productivity), 67 percent of the population in the sub region, i.e. over 215 million people, will live in areas presenting deficit conditions. This is not as dramatic as it may seem. In fact, this value includes urban populations, among whom woodfuel use is less common, and includes consumers that purchase woodfuels from the market and therefore do not depend on locally available resources.

More significant for the scope of the study is the status of rural populations, and especially the poorest segments, for which local resources are the main source of subsistence energy.

TABLE 8

Sparse rural population (<2000 inh/km²) living in different woodfuel supply/demand balance conditions in 2015 (percent; GFPOS-trend consumption scenario; mean productivity)

	Percent of rural population (density <2000 inh/km²)						
	High deficit	Medium-high deficit	Medium-low deficit	Balanced	Medium-low surplus	Medium-high surplus	High surplus
Cambodia	16.7	26.4	20.0	8.2	11.6	7.9	9.2
Yunnan (Prov. China)	1.3	4.7	6.1	4.7	13.9	16.9	52.4
Lao PDR	4.2	5.5	8.5	5.5	12.3	13.8	50.3
Malaysia	0.1	0.2	0.2	0.6	0.9	1.7	96.3
Myanmar	21.9	26.4	16.2	4.8	7.7	5.9	17.0
Thailand	9.0	18.8	21.7	10.7	16.1	9.5	14.2
Viet Nam	35.6	14.4	11.9	5.7	10.5	8.9	13.0
Total rural population	**15.8**	**16.0**	**14.1**	**6.5**	**11.6**	**9.5**	**26.5**

According to the most likely scenario, 45.9 percent of sparse rural population, or 56.8 million, will live in deficit conditions, compared with the 48.5 percent (61 million) of 2000. Out of this population, 31.8 percent (39.4 million) will face acute deficiencies (high to medium-high deficit areas). Here also, there is a small improvement with respect to the situation in 2000, where the acute-deficiency group was 35.7 percent (45 million) of rural dwellers.

In the BAU scenario, which assumes constant per capita consumption rates, the sparse rural populations living in deficit areas will be very close to 2000 estimates, with 47.9 percent (59.3 million) of people living in deficit areas and 35.6 percent (44 million) of people facing acute scarcity.

As mentioned before, these figures alone do not identify persons actually facing subsistence energy shortage. In fact, only the fraction that cannot afford commercial fuels, and therefore the poorest segments of the society, are likely to suffer directly from the lack of sufficient and locally accessible woody biomass. At the same time, alongside the rural poor, subsistence energy supply remains a problem for the poorest dwellers of booming suburbs and rural settlements, who can not afford commercial energy.

It is also estimated that a consistent fraction of the rural population will live in areas of high to medium-high surplus: 36 percent for the GFPOS-trend and 34 percent for the BAU scenarios. In these areas, the untapped (or unmanaged) sustainable production potential represents an accessible resource for poverty alleviation and socio-economic development. Such resources could be rationally managed through efficient bioenergy systems to create energy for development, income and employment in local, and usually decentralized, communities. A strengthened bioenergy sector would reduce the dependency of the countries on oil imports and would reduce greenhouse gas (GHG) emissions derived from non-renewable fuels.

The combined analysis of woodfuel balance conditions and poverty indicators, which could be done for 2000, could not be done with the 2015 dataset due to lack of projected and spatialized socio-economic indicators related to poverty.

CHAPTER 5

CONCLUSIONS

5.1 CONTRIBUTION TO POLICY FORMULATION

Relevance of wood energy

The present study confirmed the relevance of the wood energy sector in the countries of continental Southeast Asia, although with marked differences from country to country. Consumption and supply conditions projected to 2015 indicated that woodfuels would remain important, although with some changes due to a reduction in the consumption of fuelwood and an increase in the consumption of charcoal in a context dominated by marked processes of urbanization.

In spite of the paramount relevance of wood energy in both forestry and energy sectors of most developing countries, where woodfuels often represent the main forest product as well as the main sources of energy, the role of wood energy at high policy level remains marginal. One of the reasons frequently pointed out for such neglect is the absence of adequate information and the difficulty of framing this complex and site-specific issue in a coherent national context.

With respect to forestry and energy planning at national level, the information produced in this study still lacks details on physical accessibility to wood resources, and other specific national aspects. Nonetheless, the presented information represents a first step in this direction and allows segmentation of countries into zones characterized by different biomass stocking, consumption levels and local supply/demand balance conditions in relation to poverty.

For forestry services, the definition of deficit and surplus areas helps in identifying priority zones where:

- woodfuel production can become a primary forest management objective and an important driver for sustainable rural development; or, to the contrary, where
- exploitation patterns driven by woodfuel demand will go far beyond the regeneration capacity of natural formations, calling for alternative action in collaboration with energy and agriculture stakeholders and institutions.

However, deficit conditions should not be interpreted as a direct cause of deforestation, as it was sometimes done in the past (FAO, 1983), because it is now clear that such direct cause–effect mechanisms are rare. The research conducted in the last decade, including comprehensive field studies and projects, has shown that woodfuel demand and supply patterns are very site specific and that there are mechanisms of adaptation that divert the pressure on wood resources, at least for larger surfaces (Leach and Mearns, 1988; Arnold *et al.*, 2003; Mahapatra and Mitchell, 1999; FAO/RWEDP, 1997a)

It is, however, legitimate to believe that these pronounced deficit conditions may imply (i) the use of non-sustainable sources, such as land clearings for conversions to permanent agriculture, or shifting cultivations that may temporarily release large amounts of wood; and (ii) potentially non-sustainable pressure on more accessible natural formations, with their inevitable progressive degradation. Another probable effect may be a widespread shift to lower-grade biomass fuels, such as straw, residues and cow dung. All such effects pose further burdens on the environment, on agricultural productivity and, inevitably, on the poorest segments of the society that depend on these dwindling resources.

For energy agencies, wood energy maps can support the formulation of policies and strategies. Promotion of modern wood and bioenergy systems, or, in contrast, subsidizing alternative fuels could be optimized and implemented in synergy with the forestal and agricultural sectors.

In the context of poverty alleviation, the maps combining woodfuel supply/demand conditions with poverty indicators prepared for the 2000 baseline situation on the basis of available socio-economic and nutritional parameters, support the better definition of target groups and priority areas of intervention. Missing spatially-discreet poverty indicators projected to year 2015, the scenarios developed in this study may be used themselves as indicators of access, or not, to affordable subsistence energy, to be associated with other parameters.

5.2 A NEW DIMENSION IN THE PROCESS OF MAPPING EXTREME POVERTY

As mentioned before, the pixel-level balance between the potential sustainable production of woody biomass and the consumption of woodfuels is meaningful mainly for the fraction of the consumers that depend on fuelwood gathering within accessible walking distance.

In view of their implications for poor households' subsistence energy supply, the definition of deficit and surplus in a local context acquires particular relevance in the efforts to map poverty and extreme poverty, a key item in the struggle to achieve MDG 1 (eradicate extreme poverty and hunger) and MDG 7 (ensure environmental sustainability).

Many approaches exist to poverty mapping (FAO, 2003a), all predominantly based on econometric approaches combining census and survey data and several spatial modelling methods working at household level (Lanjouw, 1998; Hentschel *et al.*, 2000; Elbers, Lanjouw and Lanjouw, 2001; Deichmann, 1999) or at community level (Bigman and Deichmann, 2000; Bigman *et al.*, 2000). However, a common characteristic of poverty mapping is that geographical components (location characteristics) and environmental data are not taken into account (FAO, 2003b).

Energy-related indicators are limited to access/not access to electricity or other "conventional" energy sources for which formal statistics exist. This, from an energy perspective, inevitably leads to grouping all populations outside the grid as a single category, while there are conditions such as access or not access to "traditional" energy sources that can strongly influence the living conditions of poor households and the pressure on surrounding environments.

As pointed out in FAO (2003b), "Environmental degradation contributes to poverty through worsened health and by constraining the productivity of those resources on which the poor rely. Moreover, poverty restricts the poor to acting in ways that harm the environment. Poverty is often concentrated in environmentally fragile ecological zones where communities face and contribute to different kinds of environmental degradation."

In combination with econometric data and in addition to other indicators relevant to poverty and food insecurity (Box 2), the deficit areas identified in the present study provide important indicators for the locations where poor households are likely to face serious difficulties in acquiring minimum subsistence energy levels and where the negative effects discussed above may occur. Specifically, the definition of woodfuel-deficit areas may contribute directly and effectively to determine and qualify vulnerability levels in both poverty and food insecurity mapping.

BOX 2

POVERTY AND FOOD INSECURITY INDICATORS

Poverty categories

Economic. These include monetary indicators of household well-being, particularly food and non-food consumption or expenditure and income. These measures are primarily used by economists, but many NGO and development agencies use a variety of consumption and income measures, including non-monetary proxies of household well-being, such as ownership of productive assets or durables.

Social. These include other non-monetary indicators of household well-being, such as quality and access to education, health, other basic services, nutrition and social capital. These measures are sometimes grouped into basic-needs or composite development indices by agencies such as UNDP.

Demographic. These indicators focus on the gender and age structure of households, as well as household size.

Vulnerability. These indicators focus on the level of household exposure to shocks that can affect poverty status, such as environmental endowment and hazard, physical insecurity, political change and the diversification and riskiness of alternative livelihood strategies.

Food-insecurity categories

Direct measures of consumption. These indicators look at household or individual food intake, total and food expenditures and caloric acquisition.

Outcome indicators of nutritional status. These indicators focus on anthropometric and micronutrient indicators.

Vulnerability. This concept encompasses notions of access and availability, risk and uncertainty. Indicators include household access to assets, household size and composition, asset liquidity, crop and income diversification and food production at household level.

Source: FAO, 2003a.

The results of the study, summarized in the foregoing section, indicate that, in 2000, a large fraction of the population of the region lived in conditions of local supply/demand deficit and that the situation in 2015 would probably not improve significantly. More specifically, the study allowed areas to be identified within countries where woodfuel deficit conditions, in 2000, were coupled with high malnutrition. In these areas, the woodfuel deficit would be likely to aggravate malnutrition and health problems.

In contrast, rural communities living in areas of high surplus, equally displayed by the maps, might benefit from the untapped potential productivity for the generation of energy for development, income and employment.

The mapping of these areas represents a significant contribution to the challenging task of mapping poverty and food insecurity.

5.3 DATA QUALITY AND ANALYTICAL CONSTRAINTS

5.3.1 2000 baseline

The thematic layers produced in the study represent the beginning rather than the conclusion of an analytical process. They could, and hopefully will, support further levels of analysis at both lower and higher geographical levels. At lower levels – national and sub-national – they can serve as a basis for WISDOM analyses aimed at supporting and guiding energy and forestry policies. At higher levels – regional and global – they can contribute, and provide qualified reference, to regional and global wood energy mapping, poverty mapping and support policy formulation.

Wood energy systems, intended as the sequence of actions and elements that comprise the production, distribution and consumption of woodfuels, are complex and site specific. They may, or may not, involve trade aspects; similarly, and to some extent consequently, woodfuels may be transported far from their production sites, or they may be gathered and consumed locally; consumption patterns may change rapidly in favour of "higher" fuels such as gas and kerosene, or "lower" fuels such as agricultural residues or cow dung, in response to varying market conditions or levels of accessibility to wood resources.

Such fluid conditions cannot be predicted and modelled due to inadequate information on the driving variables and to the inherent complexity of the systems. It is therefore essential to understand the scope and limitations of the analysis carried out. In this respect, the following aspects should be highlighted:

- **Data quality.** Reference data, such as the total woodfuel consumption for a given country and the urban/rural consumption ratios, are estimates rather than objective measurements. The estimation processes behind such estimates are poorly documented or, more often, totally unknown (FAO/RWEDP, 1997a; FAO, 1997b, 2005a). The estimation of woody biomass stocking and productivity was based on regionally consistent, but rather coarse, land cover maps whose accuracy at local level is far from optimal, and on field survey references that provided only indicative values for most non-forest classes. This means that the maps produced in this study cannot be more than "best approximations" based on available data, and therefore to be used for the definition of priority zoning rather than for quantitative calculations.
- **Error margin.** It is not possible to estimate the error associated with the results of the study, since the quantitative results were not based on a uniform statistical approach but rather on a mosaic of extremely heterogeneous data sources, and also since no analysis of map accuracy was undertaken. A rough idea of the possible margin of error associated with biomass stocking and productivity, for instance, might be derived from the range of values found in the literature. The values for stocking ranged around the mean, with a factor of between 0.57 and 1.3, and a similar factor range was found for the mean annual increment (0.5 to 1.5 of the mean). Combining the two factors, it is possible to find locations where the actual productivity is as low as 0.3, or as much as 1.8, times the mapped mean. However, as can be observed from the maps shown in Figure 41, where the woodfuel supply/demand balance is mapped according to all three productivity variants (mean, minimum and maximum), the different levels of stocking and productivity affect the extent but not the locations of the main deficit areas. This tends to confirm that, as may be explained by fuzzy logic, the resulting maps acquire a reliability of their own thanks to the concurrence of so many factors and in spite of the weakness of individual quantitative parameters. Field action may therefore be implemented with good confidence within the core priority areas, while additional data may be collected in order to build up more reliable quantitative estimates where the situation is less clear and investment appears justified.

- **Spatial analysis.** The integration of supply and demand parameters and balance calculation were done with reference to an area of approximately 9 km x 9 km around each pixel. They are meaningful for locally constrained production/consumption patterns, but they do not account for imported woodfuels that may, in fact, be transported from far distances, especially in the case of charcoal. However, the area considered for supply/demand balance is consistent with the gathering horizon of rural consumers that cannot afford marketed woodfuels or that live far from market centres.
- **Sub-national aggregation.** Pixel-level parameters were aggregated at sub-national level to yield a total of 655 sub-national administrative units. The aggregation by territorial units provided balance results that go beyond the fuelwood gatherer horizon and that account for the consumption and supply potential of the entire unit. In addition, the sub-national data set allows a direct combination with socio-economic aspects that are always reported by territorial units. In this study, woodfuel supply/demand balance results were combined with best available poverty indicators in order to highlight the provinces or districts more vulnerable from a subsistence energy perspective.
- **Poverty indicators.** Much work needs to be done for mapping poverty at an acceptable spatial and thematic resolution. For the present study, only nutritional indicators were available (mainly incidence of stunt growth in children below 5 years old), except for Thailand, where a more complex vulnerability index had been developed.
- **Wood energy and poverty.** The present study can contribute significantly to the evaluation of poverty areas by adding a new indicator related to subsistence energy. In this perspective, the information available on malnutrition and vulnerability allowed a first-level identification of the areas that, presenting both woodfuel deficit and poverty conditions, are likely to suffer from shortages of subsistence energy.

At the same time, given that woodfuels are the “staple” fuels of the poorest segments of the population, poverty indicators may help to reinforce woodfuel balance analyses and the screening of priority areas. It may be assumed, in fact, that deficit conditions are truly so in the areas where household consumptions are high (poor areas), while in relatively richer areas such conditions may be more apparent than real, because marketed woodfuels transported from distant areas, together with other fuels, are accessible alternatives.

5.3.2 2015 Scenario development

Existing information on land cover changes, predictions of population distribution in 2015 and modelling studies of likely trends in woodfuel consumption induced the perception that scenario development of woodfuel consumption and production potential was possible and justified in the context of MDG efforts. However, given the limitations in the reference data sources used for the creation of the 2000 baseline, the development of future wood energy scenarios could only achieve an additional, and inevitably coarser, level of approximation.

One important element of the main information ingredients used in scenario development that may help to understand the additional level of approximation that this analysis implied, is the inevitable “smoothing” of predicted trends. The prediction of 2015 supply and demand situations was based mainly on assumed country-level land cover changes, population growth and woodfuel consumption projections. Not being able to predict “where” such changes will take place, the values were distributed somehow uniformly over the entire country area. Concerning forest areas, for instance, the probability of change was distributed evenly within buffer zones determined by distance from forest edge and high consumption sites. This process produced “smoothed” maps that cannot reflect the true site-specific character of wood energy systems and their dynamics.

It is hoped, however, that thanks to the relatively high resolution of some layers, especially concerning population distribution, the results will support the identification of areas and of segments of the population that deserve highest attention in forthcoming MDG activities, such as the areas where further data collection would make most sense in the context of poverty alleviation, health improvement and woodfuel and community forestry programmes.

CHAPTER 6

FOLLOW-UP RECOMMENDATIONS

6.1 NATIONAL WISDOM ANALYSES

Effective action towards the establishment of sustainable wood energy systems and poverty alleviation requires a field-based approach and solid institutional synergies. It is therefore recommended that WISDOM analyses be undertaken at national level in collaboration with forestry, energy and rural development agencies and other stakeholders.

The result of the present study can provide valuable input for donors and policy-makers in the identification of priority areas and countries where such WISDOM analyses are urgently needed.

6.2 IMPROVING SUBREGIONAL ESTIMATES AND SCENARIO DEVELOPMENT

In consideration of the high relevance that this type of study has in the framework of the MDG, and specifically MDG 1 (eradication of hunger and poverty) and MDG 7 (ensure environmental sustainability), it is recommended that the detailed analysis of the interrelations between poverty, environment degradation and areas with intensive fuelwood utilization be continued and improved.

However, the analysis is severely constrained by the scarcity of spatially-discrete parameters and indicators related to poverty. For the present study, only nutritional indicators were available, except for Thailand, where a more complex vulnerability index had been developed. It is therefore strongly recommended that resources be invested in the collection and mapping of the poverty-related parameters, including economic aspects such as household income levels and purchasing capacity, that are essential for defining the true impact of biomass scarcity on subsistence energy supply.

Considering the quality of reference data available and the need to expand the scope of the analysis in relation to MDG objectives, it is recommended that the following activities be undertaken:

- Improve supply scenarios at subregional level:
  - Improve the estimation of woody biomass resources on the basis of national land cover maps and additional field data collection. Particular attention should be given to forest and agricultural plantations and to non-forest land uses that are important sources of woodfuels, yet whose productive capacities are scarcely documented.
  - Undertake GIS-based studies based on transportation networks and terrain characteristics in order to estimate physical accessibility of woody biomass supplies.
  - Assess and map the production and use of forest and wood industries residues.
- Improve demand scenarios at subregional level:
  - Update information on fuelwood and charcoal consumption in rural, rural settlements and urban areas, and analyse and verify the consumption trends assumed by the GFPOS model in different sectors and areas. *Inter alia*, an element of great interest will be the influence of high oil prices on fuel substitution rates.

- Analyse interrelations with poverty zoning, based on other socio-economic parameters, and define priority areas for action within the 2015 time frame for sustainable wood energy systems and poverty alleviation.
- In critical areas, measure and evaluate the interaction among woodfuel supplies, poverty levels, health and nutritional conditions.
- Take decisive multisectoral action (investigation and mitigation) in critical areas without awaiting further study results, since many of the results already available are sufficient to identify urgent needs.

In addition, this study provides a starting point for expanding work in the agro-energy sector, which can benefit from the approach, the GIS analytical environment, the additional thematic layers and the nexus with forestry, energy and poverty alleviation issues.

It is therefore recommended that the WISDOM analytical framework be systematically enhanced to incorporate additional data and information on other biofuels, including energy crops and agricultural and livestock residues, in order to develop and extend the applications to reflect the broader bioenergy sector.

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