FUELWOOD "HOT SPOTS" IN MEXICO

A CASE STUDY USING WISDOM

Woodfuel Integrated Supply-Demand Overview Mapping







FAO Wood Energy Programme

Universidad Nacional Autonoma de Mexico - UNAM Wood Energy Programme – FAO Forestry Department

FUELWOOD "HOT SPOTS" IN MEXICO:

A CASE STUDY USING WISDOM – Woodfuel Integrated Supply-Demand Overview Mapping

Omar R. Masera, Gabriela Guerrero, Adrián Ghilardi Centro de Investigationes en Ecosistemas CIECO - UNAM Alejandro Velázquez, Jean F. Mas Instituto de Geografía- UNAM María de Jesús Ordóñez CRIM- UNAM Rudi Drigo Wood Energy Planning and Policy Development - FAO-EC Partnership Programme and Miguel A. Trossero Wood Energy Programme, Forest Products and Economics Division - FAO

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS Rome, 2004

REPRINTED 2007

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

All rights reserved. Reproduction and dissemination of material in this information product for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holders provided the source is fully acknowledged. Reproduction of material in this information product for resale or other commercial purposes is prohibited without written permission of the copyright holders. Applications for such permission should be addressed to the Chief, Publishing Management Service, Information Division, FAO, Viale delle Terme di Caracalla, 00100 Rome, Italy or by e-mail to copyright@fao.org

© FAO 2003

Foreword

A more sustainable use of woodfuels will have a positive impact on the environment and on sustainable forest management and will produce social and economic benefits such as income and employment opportunities to decentralized communities. To this end, the Wood Energy Programme of FAO is broadening and disseminating knowledge and information on wood energy aspects and actively collaborating with member countries in the development and implementation of planning tools supporting wood energy planning and policy formulation.

The most critical limitation in the formulation of wood energy policies commonly pointed out is the lack of reliable information on woodfuel production and consumption, but this is a somewhat misleading perception. The information is poor and contradictory, no doubt, but this is more often the result than the cause of the absence of sectoral policies. In most cases, the problem is not lack of reliable data per se but rather the lack of clear institutional responsibilities and of a comprehensive analytical perspective, which prevents the proper use of the information that exists in the forestry and energy agencies of most countries.

FAO, under the request of the Govermnment of Mexico, funded the project "Wood energy for rural development" (TCP/MEX/4553) which provided a detailed analysis of the wood energy situation in Mexico. As a follow up of this project and in order to promote the adoption of a comprehensive analytical perspective and thus to favor the definition of institutional responsibilities, the Wood Energy Programme of FAO and the Center for Ecosystems Research of the National University of Mexico developed the Woodfuel Integrated Supply / Demand Overview Mapping (WISDOM), a spatially-explicit method for assessing woodfuel sustainability and supporting wood energy planning through the integration and analysis of existing demandand supply-related information.

In the Mexico study here presented, the analysis was conducted at two different scales: at national scale, in which it allowed the definition of priority areas or fuelwood "hot spots", and at sub-national scale in the "Purhepecha" Region (one of the priority regions), where it allowed the definition of different pressure zones according to accessibility aspects. In this multi-scale analysis WISDOM expressed its potential as national strategic planning tool as well as operational tool for sub-national planning.

The results of the Mexico study - in terms of the identification of priority areas or fuelwood "hot spots"- have been incorporated by the National Forestry Commission, which plans to launch a program of efficient woodburning cookstoves and multi-purpose energy plantations directed to those areas.

In addition to the Mexico case, the WISDOM approach has been so far implemented in Senegal and Slovenia. Confronted with very diverse contexts, WISDOM has proved to be flexible and adaptable, always able to consolidate fragmented knowledge and to produce clear perceptions of woodfuel production/consumption patterns. It is interesting to note that the priorities identified in the three cases are very different. In Mexico the critical aspect is the sustainability and access of fuelwood supply sources in specific users' contexts (fuelwood "hot spots"); in Senegal the main issue is the trend in charcoal consumption in rural villages. Finally, in Slovenia the definition of biomass resources available for energy purposes and the socioeconomic constraints that limit the access to such resources are the most relevant aspects. In each case, the analysis was based on the integration of information already existing in the countries, which shows also the cost-efficiency of the WISDOM approach.

fling hi

Wulf Killmann Director Forest Products and Economics Division Forestry Department FAO

Summary

Adequately understanding the environmental and socio-economic implications of the current patterns of woodfuels production and use and their resource potentials is a critical task for promoting the sustainability of these energy sources. The inherent site specificity of woodfuel situations challenges conventional energy planning methods based on aggregate information, and require to coherently and efficiently articulate the local heterogeneity into the national or regional level. Multi-scale spatially-explicit approaches have much to offer for achieving this latter task.

This study uses the Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) methodology to identify woodfuel priority areas or household fuelwood "hot spots" in Mexico. WISDOM is a spatially-explicit method oriented to support strategic planning and policy formulation through the integration and analysis of existing demand and supply related information and indicators. In the present report, Mexican *municipios* (first sub-state administrative unit) are categorized into five priority groups. Further analysis at a higher resolution is conducted using accessibility to forests and fuelwood user's densities, over the Purhepecha Region of Michoacan State to preliminary identify concrete areas for project implementation.

The WISDOM analysis confirmed the high heterogeneity of fuelwood situations within Mexico, allowing the identification of 262 high-priority *municipios*, out of a country total of 2,401. *Municipios* were ranked based on the number of fuelwood users; the percentage of households that use fuelwood; the density and growth of fuelwood users; the resilience of fuelwood consumption, and the magnitude of woodfuel forest resources.

The spatially-explicit accessibility analysis conducted over the Purhepecha Region shows that 40% of the forest area is actually accessible to fuelwood gatherers at one hour distance (round trip) from their homes. This portion rises to 80% when considering a walking round trip of two hours. Approximately 13% of the accessible forests are estimated to suffer the highest pressure from fuelwood harvesting due to their proximity to more populous settlements.

Table of Contents

Foreword	iii
Summary	iv
Table of Contents	v
List of Figures	vii
Acknowledgments	viii
1. INTRODUCTION	1
2. THE WISDOM APPROACH	3
Assessing and strategic planning tool	3
WISDOM steps	4
3. IDENTIFYING FUELWOOD "HOT SPOTS" AT THE NATIONAL LEVEL	7
Mexico's current pattern of woodfuel use	7
WISDOM analysis for Mexico	8
STEP 1: Determining the minimum spatial unit of analysis: the "municipio"	9
STEP 2: Development of the DEMAND module	11
STEP 3: Construction of the SUPPLY module	12
STEP 4: Integration module	16
STEP 5: Identification of Mexican fuelwood "hot spots" at the municipio level	16
1) Selection of a final set of variables	1/
2) Grouping of municipios for each variable 3) Construction of an integrated Euclywood Priority Index (EPI)	20
4) Ranking of municipios in 5 groups according to the FPI: defining "hot spots" municipalities	20
Statistical analysis	21
Overall results	23
Results for each variable used to construct the FPI	23
Results from the priorization of municipios	30
Net CO ₂ emissions from fuelwood non-sustainable use by the residential sector	35
4. IDENTIFICATION OF FORESTS UNDER FUELWOOD HARVESTING PRESSURE WITHIN PRIORITY	
MUNICIPIOS: AN ACCESSIBILITY ANALYSIS	37
The "Purhepecha" Region	38
Methods	39
Estimation of the potential forest areas accessible to fuelwood users of the Purhepecha Region	39
Categorization of accessible forest areas according to the pressure exerted by local people's demand	43
Kesults	46
5. CONCLUSIONS	51
6. REFERENCES	53
7. ANNEXES	57
Annex 1. List of municipios according to their classification into high, mid-high and medium priority groups Annex 2. Accessible forest areas of municipios of the Purhepecha Region disaggregated by density groups	57 87

List of Tables

Table 1. Main characteristics of the case study in Mexico 9
Table 2. Variables used in the demand module
Table 3. Average per capita fuelwood consumption coming from forest areas
Table 4. Land use and land cover classes used in the Mexican case study
Table 5. Average aboveground biomass production by main forest type 15
Table 6. Variables used in the supply module
Table 7. Correlation coefficients for the full set of fuelwood related variables 18
Table 8. Variables selected and threshold values for the construction of the indexes 18
Table 9. Values of the FPI by group of priority municipios 21
Table 10. Analysis of variance of the six dependent variables of the FPI 21
Table 11. Characteristics of each priority group of <i>municipios</i> according to the six variables used in the FPI34
Table 12. Characteristics of each priority group of <i>municipios</i> according to selected variables of importance.34
Table 13. Net CO2 emissions from the non-sustainable use of fuelwood by the residential sector, disaggregated by representative municipios
Table 14. Mean displacement velocities of fuelwood gatherers according to slope angles
Table 15. Information used for conducting the accessibility analysis 44
Table 16. Accessible forest areas of the Purhepecha Region by walking fuelwood gatherers, and furtherpriorization according to four fuelwood users densities47

List of Figures

Figure 1. WISDOM Steps
Figure 2. Mexico's energy consumption in the residential sector (1965 - 2001)
Figure 3. Share of fuelwood on total wood demand in Mexico
Figure 4. Spatial administrative units within Mexico
Figure 5. Simplified vegetation map for Mexico, 2000
Figure 6. Assumed biomass productivities for Mexican forests, 2000
Figure 7. Statistical differences among groups of <i>municipios</i> according to selected variables
Figure 8. Number of fuelwood users, Mexico 2000
Figure 9. Density of fuelwood users, Mexico 2000
Figure 10. Growth of fuelwood users, Mexico 1990-2000
Figure 11. Saturation of fuelwood users, Mexico 2000
Figure 12. Percentage of indigenous population, Mexico 2000
Figure 13. Fuelwood balance, Mexico 2000
Figure 14. Potential pressure on local forests from the extraction of fuelwood, Mexico 2000
Figure 15. Priority municipios in terms of fuelwood use and availability of fuelwood resources, Mexico 2000 30
Figure 16. Priority <i>municipios</i> in terms of fuelwood use and availability of fuelwood resources, Mexico 2000. Deta for the Central Region
Figure 17. Priority <i>municipios</i> in terms of fuelwood use and availability of fuelwood resources, Mexico 2000. Deta for the Central Gulf Region
Figure 18. Priority <i>municipios</i> in terms of fuelwood use and availability of fuelwood resources, Mexico 2000. Deta for the South Pacific Region
Figure 19. Estimated Net Emissions of CO2 from the non-sustainable use of fuelwood, Mexico 2000
Figure 20. Priority <i>municipios</i> for the Purhepecha Region
Figure 21. "Time distance" map
Figure 22. Buffers around settlements based on the "time-distance" map
Figure 23. Forests cover of the Purhepecha Region, 2000
Figure 24. Density population map of the Purhepecha Region considering 3 Km radius circles around settlements 43
Figure 25. Accessible forest areas of the Purhepecha Region at one-hour walking round trip from each settlement 40
Figure 26. Accessible forest areas of the Purhepecha Region at one-hour walking round trip from each settlement according to four fuelwood users densities
Figure 27. Accessible forest areas of "Nahuatzen", a <i>municipio</i> in the Purhepecha Region, at one-hour walking round trip from each settlement, according to four fuelwood users densities

Acknowledgments

This paper has been compiled, in close collaboration, by the Centre for Ecosystems Research (CIECO) of the National Autonomous University of Mexico (UNAM) and the Wood Energy Programme of the Forest Products Division of FAO.

It was drafted by Omar R. Masera, Professor of Energy and the Environment at the Centre for Ecosystems Research of UNAM, Gabriela Guerrero and Adrián Ghilardi, Research Assistants at the Centre for Ecosystems Research of UNAM, Alejandro Velázquez and Jean Francois Mas, Professors at the Institute of Geography, UNAM, María de Jesús Ordóñez, Associate Professor at the Regional Center for Multidisciplinary Research, and Rudi Drigo, Consultant with the wood energy component of the "Sustainable Forest Management Programme in African ACP Countries" Project of the FAO-EC Partnership Programme. Miguel Trossero, Senior Forestry Officer responsible of FAO Wood Energy Programme, provided technical advise and supported in various ways the initiative, including the publication of the present document.

Many other persons provided extensive contributions, assistance and personal insights for the finalization of the document. Special mention should go to Massimiliano Lorenzini, who advised on GIS issues. Valuable comments and suggestions where received by the participants of the Biomass Working Group at the International Seminar on Bioenergy and Sustainable Rural Development held in Morelia, Mexico in June 2003.

Sincere gratitude is also expressed to the European Commission for its financial support to the wood energy component of the project on: "INFORMATION AND ANALYSIS FOR SUSTAINED FOREST MANAGEMENT, An integrated national and international effort involving the tropical countries of Latin America and the sub-Saharan countries of Africa" (GCP/RLA/133/EC) and (GCP/RAF/354/EC) respectively.