Karst Forests and their Benefits:
A Comparison between Local and Expert Knowledge

Tania López-Marrero, Nicole M. Balloffet, Hedy I. Nieves-Crespo, and Marianne Meyn

Introduction

Participatory and collaborative resource management is important for the conservation and wise use of natural resources. Developing strategies that bring different groups of people to share, think, learn, and act together, however, requires understanding existing common knowledge and topics of interests, as well as gaps in information and divergences among different groups.

This publication compares the findings obtained from a study conducted with "experts" and residents regarding the northern karst forests and the benefits these forests provide. With this type of information, natural resource managers, educators, community groups, and others are better equipped to develop and implement initiatives that enhance public knowledge, promote dialogue and discussion among groups, engage people in conservation efforts, and ultimately promote participatory management and conservation of natural resources.

Data collection

A total of 30 people that work in some aspect related to the karst forests participated in the project. They are referred to in this publication as "experts". Participants included scientists (7), municipal planners from municipalities within the karst region (5), personnel from the Department of Natural and Environmental Resources (3), professionals that work in areas related to natural resource management, water resources, geology, and air quality (6), people from non-governmental organizations and environmental groups (8), and personnel from the pharmaceutical sector within the karst region (1). A total of 127 residents from twelve communities within the karst region (in the surroundings of Cambalache and Río Abajo State Forest) participated in the study (see the publications "Public Knowledge and Perceptions about Karst Forests and their Benefits", another title within the "ConoBosque publication" series for more information).

Questionnaires including closed- and open-ended questions were the means of data collection in this project. The questionnaire included questions regarding participants' knowledge about karst forests, their benefits, and the factors influencing benefits provision. The questionnaire also included questions regarding information needs about karst forests. On-line questionnaires were sent to experts via internet and completed electronically by them. On some occasions, the questionnaires were carried out with experts by one of the research team members using the "face-to-face" technique. Data collection took place during July and August 2010. Additionally, a workshop with some experts was conducted to discuss the preliminary results of the project and to further obtain their opinion about information needs and ways to increase knowledge and awareness about the karst forests and the factors affecting them. This workshop took place in August 2010. In the case of residents, all questionnaires were administered and filled out personally ("face-to-face" technique by members of a the research team). Data collection with residents took place during June 2009.

Findings

Benefits provided by karst forests

Many of the benefits provided by the karst forests were identified by both groups of participants, i.e., residents and experts. Certain benefits were only identified by the group of experts; specifically, maintenance of biodiversity, soil formation, and nutrient cycling. These benefits are generally process-oriented ones. On the other hand, spiritual value and rainfall were only mentioned by residents.

Residents' knowledge and perceptions about the benefits provided by karst forests tended to be closely related to concrete and every-day experiences. The benefits they identified mostly were related to a direct use or those that can be directly sensed: forest products they obtain (mentioned by 81% of the residents), temperature regulation (76%), flora and fauna (75%), and air purification (62%). Contrary to community members, experts mostly identified water and flora and fauna (both mentioned by 90% of those participants), followed by habitat for flora and fauna (87%) and recreation (67%). When compared with the residents, only 53% of the experts mentioned forest products and just 20% of them mentioned temperature regulation benefits; whereas only 39% of the residents identified water as a benefit provided by karst forests (Figure 1).

There was a clear difference in terms of the three most important benefits identified by the two groups of participants. On the one hand, residents highlighted the importance of forests for air purification and oxygen production. Conversely, experts stressed the importance of water (and associated benefits of water recharge and retention) and water purification when identifying the most important benefits provided by forests in the karst region. Nonetheless, community residents did mention water and water purification among the three forest benefits they consider as most important, but compared to air-related benefits, water-related ones were less identified and, in the case of water, it was given relatively less importance. Even though water purification had a high importance value, it was identify by very few residents (1%) as one of the most important benefits they identified (Figures 2a and 2b).

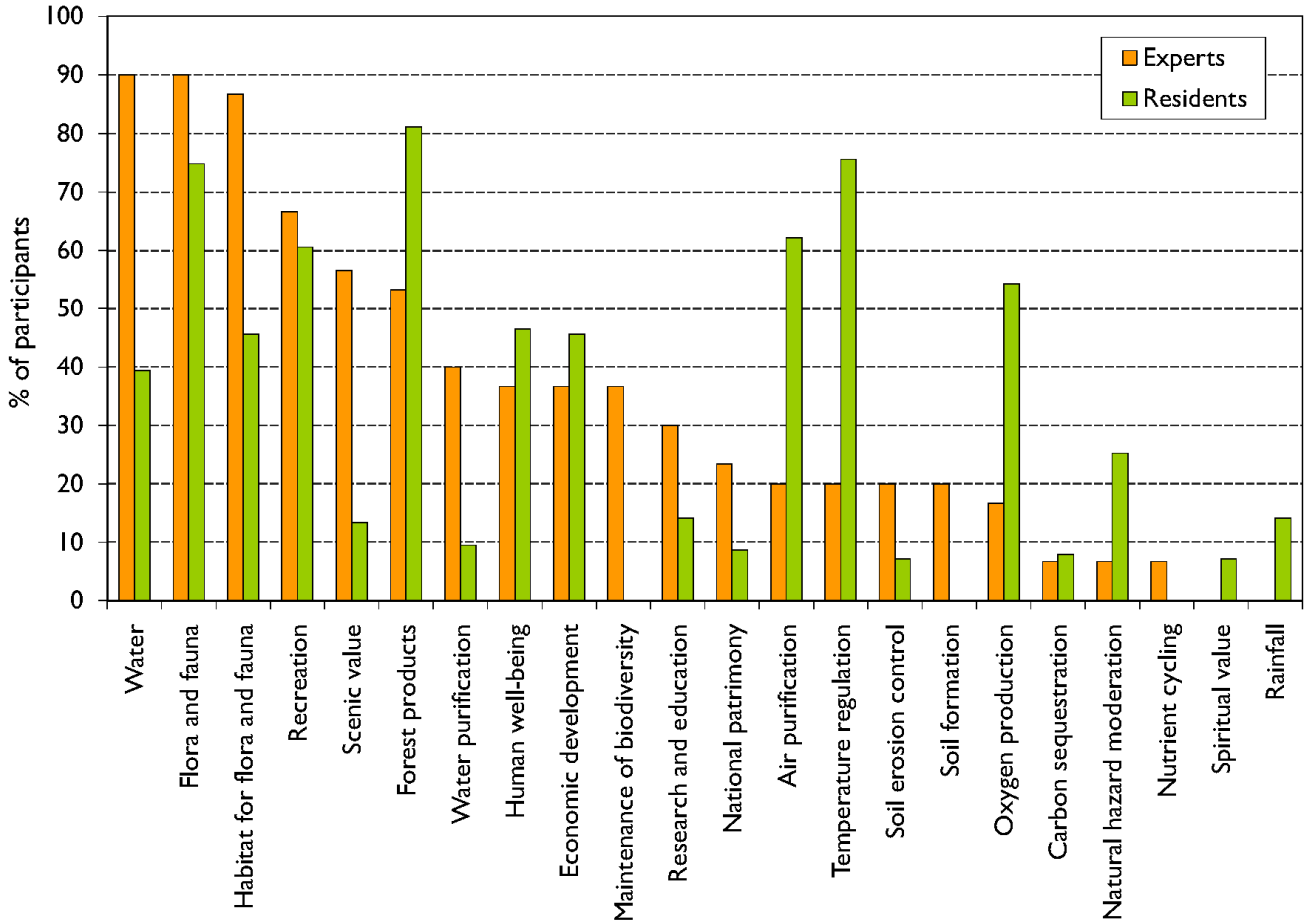

Figure 1. Benefits of karst forests mentioned by experts and residents (Table 1 describes each benefit)

Table 1. Description of the benefits provided by karst forests

Benefit	Description *
Water	Surface and underground water from rivers, streams, and springs for human consumption; water recharge, storage, and retention
Forest products	Forest and plant products, including wood, seeds, flowers, ornamental plants, medicinal plants, and food (e.g., fruit, vegetables, fisheries)
Temperature regulation	Shade, cool air, reduction of temperature
Flora and fauna	Animals and vegetation associated with forests, including endemic and endangered species
Air purification	Filtering and absorption of air pollutants
Recreation	Passive and active recreation, including hiking, camping, picnics, family get-togethers
Oxygen production	Production of air; named by some as "natural lungs"
Human well-being	Mental and physical health, including therapy, tranquility, relaxation, peace, physical exercise
Economic development	Direct and indirect income-generating activities, including ecotourism and handicraft selling
Habitat for flora and fauna	Plant and animal habitat, refuge, shelter, and reserve for species protection, specially for endemic and endangered species
Natural hazard moderation	Protection against, and damage reduction from, natural hazards, including tropical storms, flooding, and landslides
Rainfall	Production and regulation of precipitation and humidity
Research and education	Advance of scientific knowledge and knowledge transfer; forest use for educational activities, learning about nature
Scenic value	Natural beauty, pleasing landscapes, beautiful views
Water purification	Cleaning and purification of water through sediment reduction and water pollutants filtration
National patrimony	Historic and archeological importance
Carbon sequestration	Capture of carbon dioxide and its role in reducing climate warming
Soil erosion control	Soil retention and prevention of soil loss
Soil formation	Soil production through the weathering of parental material and decomposition of organic matter
Nutrient cycling	Flow and recycling of nutrients
Maintenance of biodiversity	Processes that support the diversity of plants and animals, such as reforestation, restoration, natural successions, pollination
Spiritual value	A place to pray, meditate, seek spiritual fulfillment

* The description of each benefit is based on how participants described the benefits, hence the descriptions do not necessarily follow any pre-established definitions.

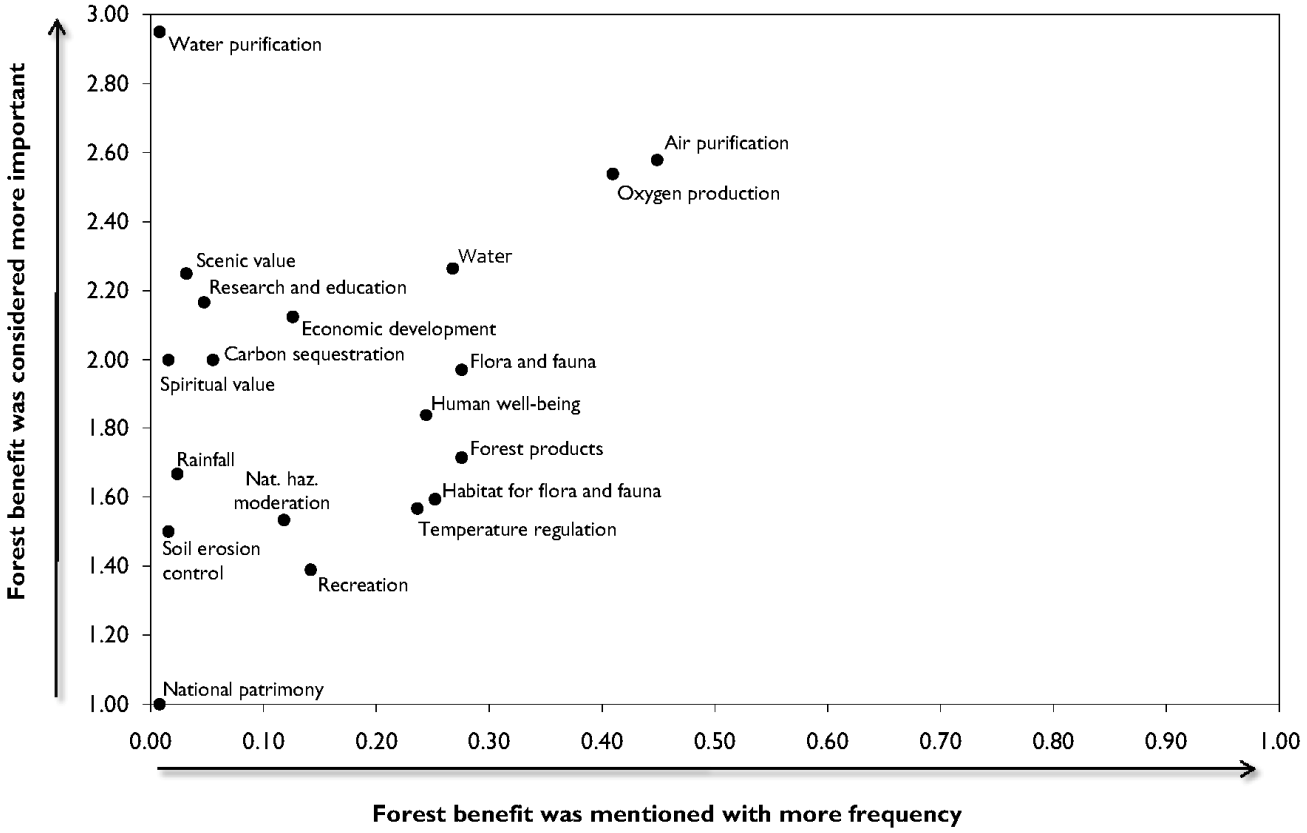

Figure 2a. Summary of the three most important karst forest benefits mentioned by residents

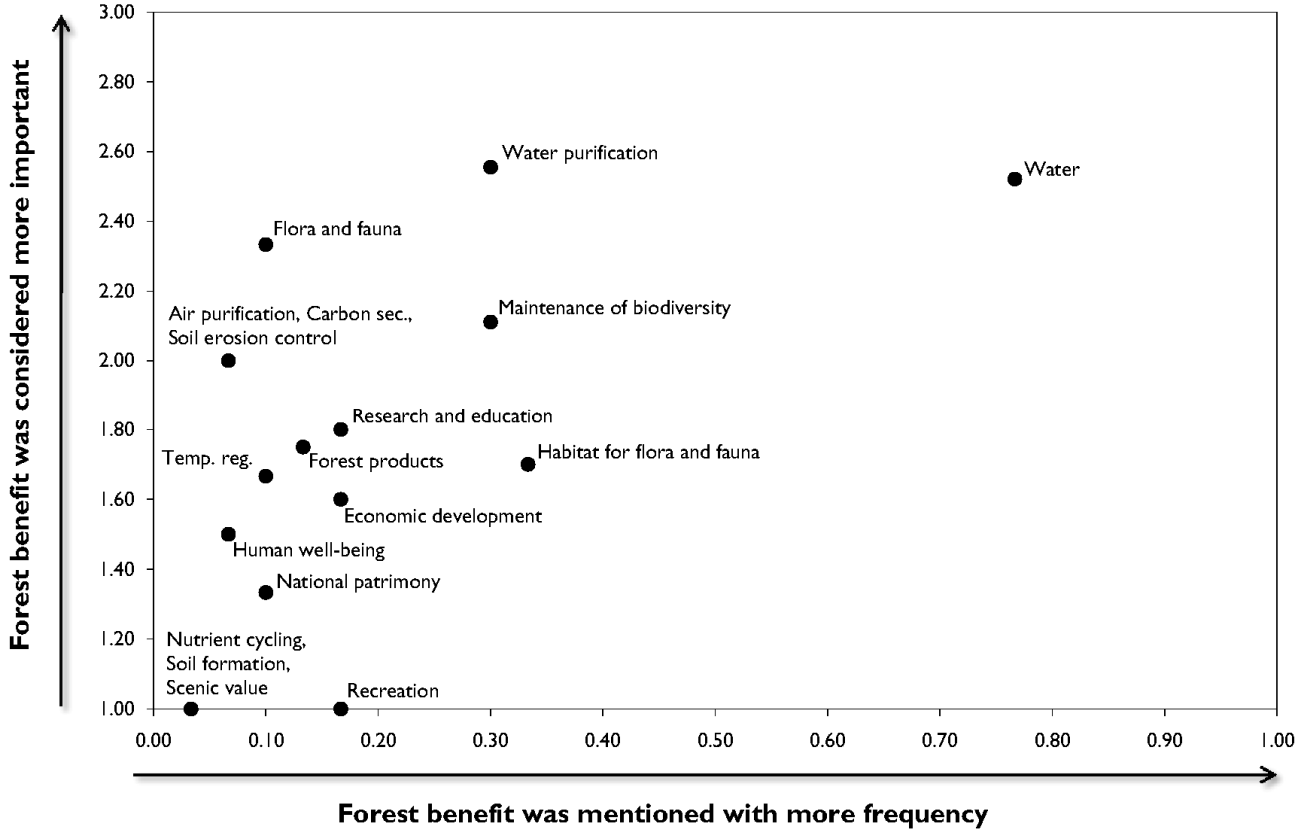

Figure 2b. Summary of the three most important karst forest benefits mentioned by experts

Provision of karst forest benefits and factors affecting the forests and their benefits

Overall, both community participants and experts perceived that the provision and quality of those benefits they identified as most important was decreasing over time. Land cover change –including deforestation and construction– and environmental pollution were the main factors both groups of participants identified as being responsible for that tendency (Figure 3). For the residents, however, environmental pollution was mostly associated to air-related benefits, including air pollution caused by nearby chemical and pharmaceutical industries, and transportation (increase of cars and traffic). For experts, on the other hand, environmental pollution was more related to water pollution.

Both groups identified education as a positive factor influencing karst forests and their benefits. Community participants also identified conservation efforts, while experts identified reforestation. Nevertheless, both groups recognized more negative than positive factors influencing karst forests.

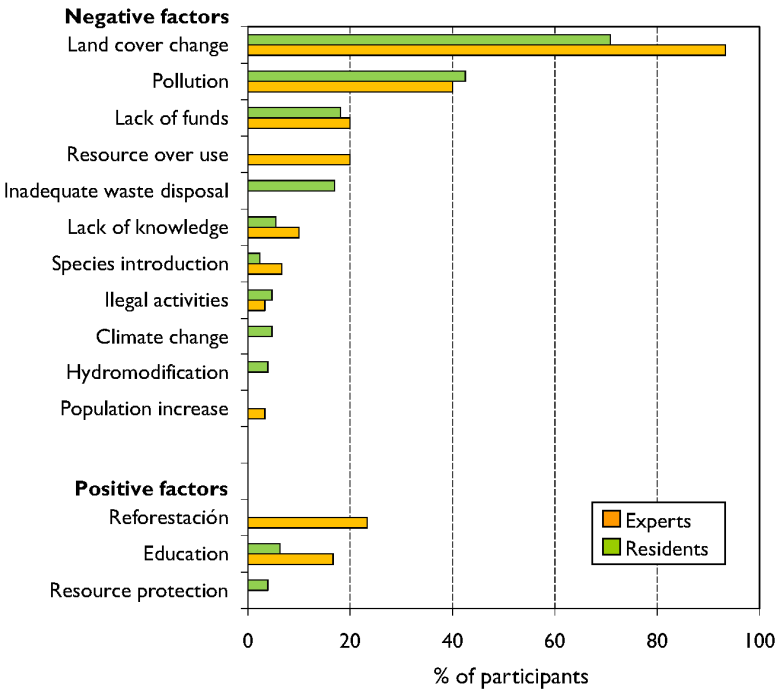

Figure 3. Residents' and experts' perception of the factors affecting karst forests and the services they provide (Table 2 describes each factor)

Table 2. Description of the negative and positive factors affecting karst forests and their benefits

Negative factor	Description *
Land cover change	Changes in the vegetation or material that covers the karst region, mainly associated with forest loss and urban expansion
Pollution	Pollution of air and water resources, mainly associated with industrial, particularly pharmaceutical processes, and transportation
Lack of funds	Lack or limited funds to increase personnel to attend forests maintenance and facilities
Resource over use	Water over extraction
Inadequate waste disposal	Inadequate solid waste disposition, including trash disposal in rivers, illegal dumping, and waste burning
Lack of knowledge	Lack of or limited knowledge about the benefits provided by karst forests and human actions that affect the forests
Climate change	Local and global climate change and the potential effects on local precipitation patterns
Illegal activities	Lack of security within and around the forest (e.g., criminality)
Hydromodification	Change of rivers' natural paths
Species introduction	Introduction of exotic, invasive, domestic, and predatory species
Population increase	Increase of human population in the karst region
Positive factor	**Description ***
Reforestation	Increase of forest cover within the karst region
Education	Knowledge transfer and environmental awareness about the forests and their benefits
Resource protection	Protection status of forests, and the laws and regulation associated with that protection

* The description of each factor is based on how participants described the benefits, hence the descriptions do not necessarily follow any pre-established definitions.

Negative aspects associated with karst forests

Most participants from both groups did not relate anything negative to the karst forests. For those residents who did, negative elements included the fear of, or unwanted, animals (mentioning specifically "poisonous" animals, snakes, monkeys, iguanas, insects, mongooses), forests being solitary areas prone to criminal activities, the fear of getting lost in the forest, the fear of extraterrestrials in the forest, the potential risks related to landslides and tree fall, and the incidence of allergies related to forests. For experts, on the other hand, the identified negative elements were fewer, and were associated with the difficulties of managing the karst forests (because of poor soils and unknown plant adaptations), and, similar to community members, the potential risks related to landslides and tree fall.

Information needs about karst forests

For both groups, residents and experts, it was important to disseminate information regarding the benefits provided by the karst forest and its flora and fauna. Experts also highlighted the need to provide information to the general public about the relationships between forest cover and water resources, including benefits associated with filtration, recharge, and water quality. Other kinds of information suggested by experts to be disseminated included the cause-and-effect of human activities on karst forests and actions to take in order to protect karst forests (Figure 4).

Regarding the tools and materials to include information about the karst forest, both community participants and experts identified talks and workshops, as well as brochures as important tools (Figure 5). Community members also expressed an interest in educational books, while experts tended to prefer educational videos as a tool to disseminate information. In terms of formats for information transfer, personal communication, television, and printed materials were seen as effective formats among both groups. Experts also identified the internet as an important means to transfer information, but this format was not mentioned as much by community participants (Figure 6).

Experts provided specific examples and suggestions for disseminating and transferring information about the karst forests:

- the development of attractive webpages
- the use of online tools such as Facebook and Twitter
- advertisement in newspapers, radio, and television
- articles or educational activities for children in newspapers (for example, one participant mentioned the dominical section "*Mi pequeño día*", in the newspaper *El Nuevo Día*)
- guided visits to the karst forests
- talks to organized groups, such as schools and churches
- short videos accessible through You tube
- the development of educational games
- camps that promote interaction with nature and hands-on experiences
- information to include in school curricula

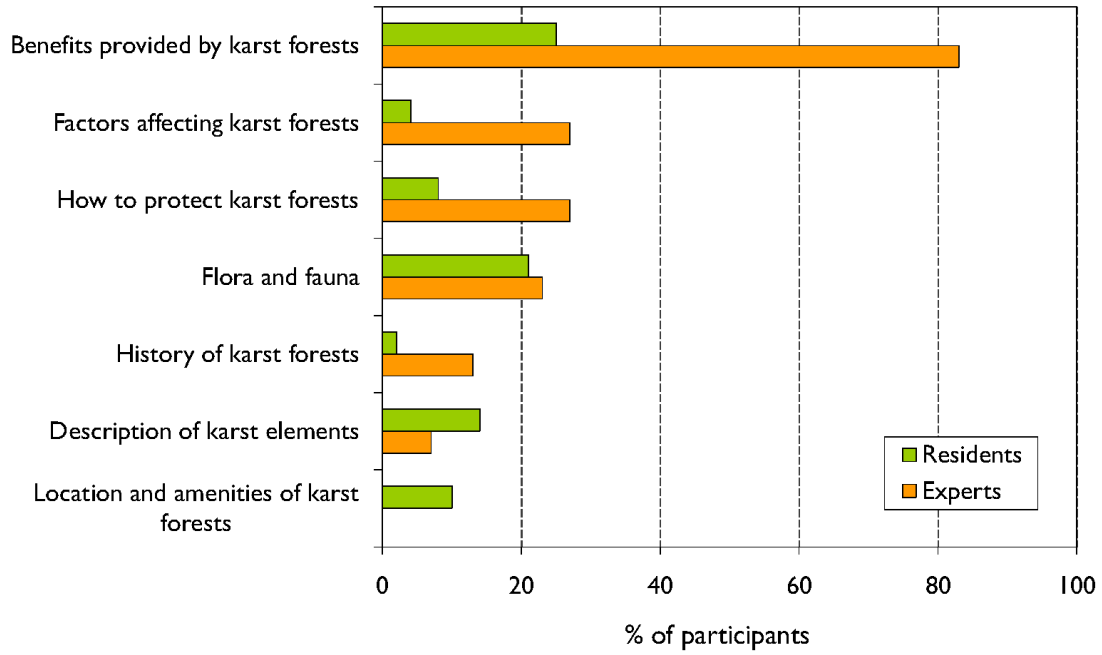

Figure 4. Information suggested to be disseminated

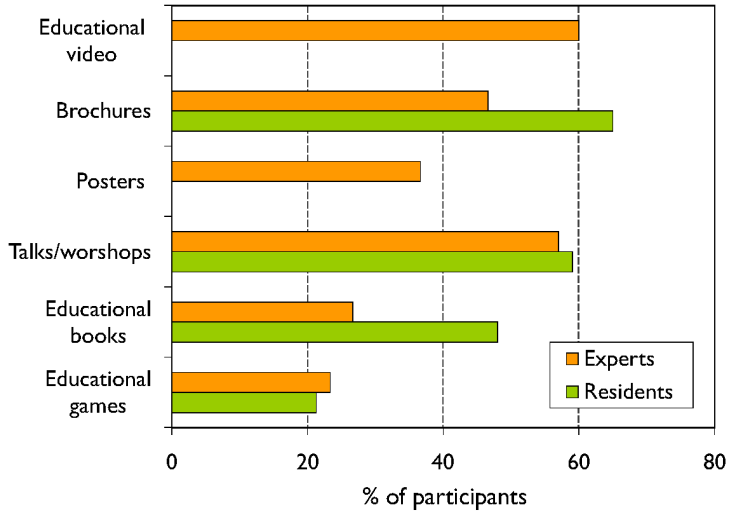

Figure 5. Preferred informational tools

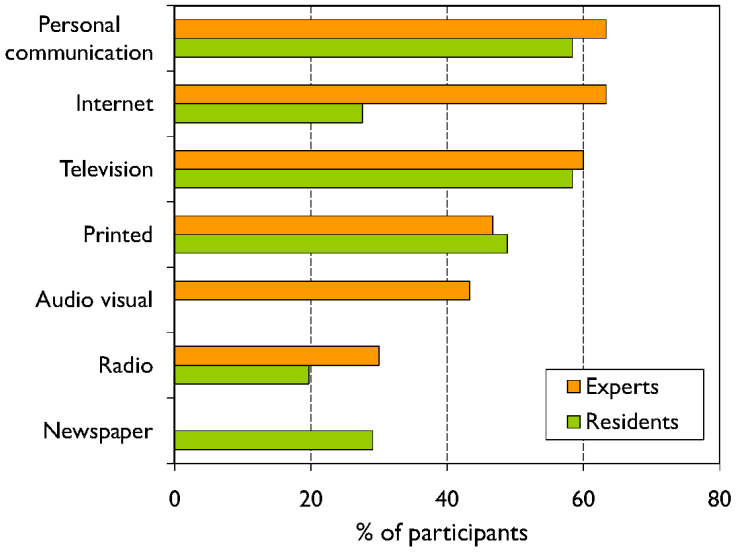

Figure 6. Preferred formats or media for information transfer

Moreover, experts suggested varied audiences to whom information about karst forests should be provided including the general public, the media, teachers, and community groups (Figure 7). Specific actors and groups mentioned included:

- teachers (different grades and disciplines)
- reporters (both written and television)
- regulatory agencies
- members of Legislature
- majors and municipal officials, particularly from those municipalities in the karst region
- businessmen, particularly from those municipalities in the karst region
- developers and private environmental planners

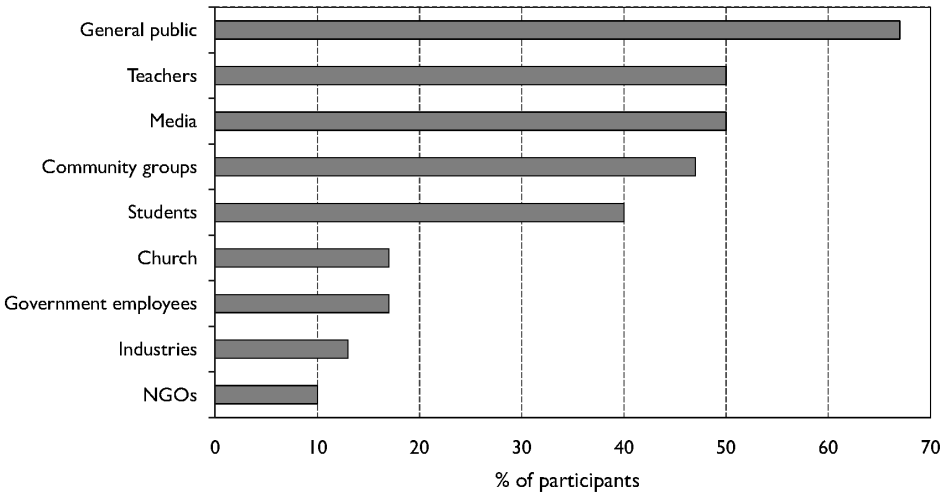

Figure 7. Suggested audiences for information transfer

Summary and recommendations

The comparison of the results from questionnaires conducted with experts and residents helped to identify the varied knowledge about the karst forest and the elements the two groups esteemed more important regarding their benefits and the factors affecting those benefits.

Many of the benefits provided by karst forests were identified by both groups of participants; however, their mentions varied in terms of which ones were more frequently cited and valued by participants from the two groups. Residents tended to identify more and give more importance to air-related benefits associated with forests, particularly air purification and oxygen production. Experts, on the other hand, tended to favor water-related benefits; specifically the role of karst forests regarding water quality, recharge, and storage. For experts, air-related benefits, although identified as benefits provided by the karst forests, were not considered as important when compared to water-related benefits. Hence, in the development of educational strategies, awareness initiatives or any other intent to increase the public's knowledge and involvement, it might be worth highlighting those known benefits which are usually related to the every-day life of people. Furthermore, emphasis should be placed on explaining important benefits which were often left out, as for instance, the role of forests for water resources.

Participants from both groups agreed that the provisioning of karst forest benefits was decreasing over time, and identified changes in land cover as the main factor for this trend. Common areas of concern –in this case perceived decrease in benefits provision and the possible association with land cover changes– can be used as a starting point to initiate dialogue, exchange information, and promote learning among groups. In this respect, for instance, providing information about what land cover changes are occurring and where, and the process by which these changes affect forest benefits are key issues since the process by which land cover changes affect forests and their benefits was less understood.

Taking into consideration the preferred type of data, tools, and media to disseminate information about karst forests and their benefits is also important when developing educational strategies, awareness campaigns, and when identifying effective ways to engage people and promoting collaboration between groups of people.

About the authors

Tania López-Marrero is an Assistant Professor in the Department of Geography and the Department of Latino and Hispanic Caribbean Studies at Rutgers University, **Nicole M. Balloffet** is a Natural Resources Specialist with the USDA Forest Service, **Hedy I. Nieves-Crespo** is an undergraduate student in the Department of Sociology and Anthropology at the University of Puerto Rico, **Marianne Meyn** is a Community Organizer at Misión Industrial de Puerto Rico.

How to cite this publication

López-Marrero, T.; Balloffet, N.M.; Nieves-Crespo, H.I.; Marianne, M. 2011. Karst Forests and their Benefits: A Comparison between Local and Expert Knowledge. [ConoBosque Briefing]. San Juan, PR: Misión Industrial de Puerto Rico. 8 p.

Other titles in the "ConoBosque publication" series

Public Knowledge and Perceptions about Karst Forests

Public Knowledge and Perceptions about Urban Forests in a Watershed Context

For more information

For more information or if you have questions, contact Tania López-Marrero, tanialm@rci.rutgers.edu or Marianne Meyn, marianne.meyn@gmail.com.

This publication was made possible through a grant from the USDA Forest Service, International Institute of Tropical Forestry, State and Private Forestry (Grant number 09-DG-11120107-013).