Reforestation study shows trade-offs between water, carbon and timber

May 23 2013

More than 13,000 ships per year, carrying more than 284 million tons of cargo, transit the Panama Canal each year, generating roughly $1.8 billion dollars in toll fees for the Panama Canal Authority. Each time a ship passes through, more than 55 million gallons of water are used from Gatun Lake, which is also a source of water for the 2 million people living in the isthmus.

However, the advent of very large "super" cargo ships, now more than 20 percent of the ships at sea, has demanded change. The Panama Canal is being expanded to create channels and locks three times larger than at present, leaving the authority to consider how best to meet the increased demand for water. One proposed measure is the reforestation of the watershed.

To help planners and policy makers understand the effects of reforestation, ASU scientists Silvio Simonit and Charles Perrings studied the effects of reforestation on a 'bundle' of ecosystem services: dry-season water flows, carbon sequestration, timber and livestock production.

Published this week in *Proceedings of the National Academy of Sciences* (*PNAS*), their study – "Bundling ecosystem services in the Panama Canal Watershed" – examines precipitation, topography, vegetation, and soil characteristics to model on-site and off-site effects of several reforestation options.

"The Panama Canal watershed is currently being reforested to protect the dry-season flows needed for canal operations. We find however that reforestation does not necessarily increase water supply, but does increase carbon sequestration and timber production," said Simonit. "Our research provides an insight into the importance of understanding the spatial distribution of the costs and benefits of jointly produced services." Simonit, a member of ASU's Ecoservices Group co-directed by Perrings, is part of a collaborative research partnership between ASU and the Smithsonian Tropical Research Institute (STRI). He is also a post-doctoral fellow on the National Science Foundation-funded research coordination network: Biodiversity and Ecosystem Services Training Network (BESTNet).

Simonit and Perrings found that only 37 percent of the currently forested area positively impacts dry-season water flows, offering up roughly 37.2 million cubic meters of seasonal flow (equivalent to US $16.37 million in revenue to the Panama Canal Authority).

In parts of the watershed not currently under forest, they found that reforestation of areas with high precipitation rates, flat terrain, and soil types with high potential infiltration would enhance dry-season flows. However, they note that these conditions exist in less than 5 percent of watershed not currently under forest.

"Water supply is, however, only one amongst many ecosystem services affected by reforestation of the watershed," said Perrings, a professor in the School of Life Sciences in ASU's College of Liberal Arts and Sciences. "And the balance between services depends on the type of reforestation undertaken." Accordingly, the duo investigated two reforestation scenarios: natural forest regeneration and teak plantation.

"We found that if all existing grasslands were allowed to regenerate as natural forest, there would be a reduction in dry-season flows across the

watershed of 8.4 percent, compared to 11.1 percent if reforestation took the form of teak plantations." In both cases, these conditions potentially pose a problem for the Panama Canal Authority. Even with water-saving advances in the new locks, the canal is expected to need 14 percent more water when the expansion takes full effect, and other options for securing dry-season flows are not cost-free. However, the Panama Canal Authority is not the only beneficiary of the watershed, and water is not the only ecosystem service supplied. "Both natural forest and teak plantations offer benefits in the form of carbon sequestration and timber products, among other things, and these should be weighed against any water losses," said Perrings.

According to their study, water losses from "natural" forest regeneration would be compensated by the value of carbon sequestration in 59.6 percent of the converted area at current carbon prices. On the other hand, reforestation of existing grassland with teak (under sustainable forest management) would generate gains sufficient to offset the hydrological losses in all converted areas, regardless of the value of carbon.

The authors note that their study does not consider the value of land cover as habitat for wild fauna and flora. However, they say their results could help canal planners prioritize reforestation efforts. Knowing what to plant and where can reduce the negative impact of forests on dry season water flows, while providing other important ecosystem services.

Provided by Arizona State University