

AI for Earth Grantee Profile

Patagonian Institute for the Study of the Continental Ecosystems
Automating the mapping of land use and land cover

Summary

The Chubut watershed, located on the arid Patagonian steppe, is the main source of water for 250,000 people. Due to climate change, water yield is expected to decrease by an estimated 20 to 40 percent in the Chubut River by the end of the century. Since 2018, Dr. Ana Liberoff of the Patagonian Institute for the Study of the Continental Ecosystems and her colleagues have worked to model the impacts of human practices on water quality and quantity. An important input for modeling human impacts are land use and land cover (LULC) maps. Deep learning neural network algorithms can facilitate standardized methods for producing consistent LULC maps, allowing for more accurate tracking of changes over time. The AI for Earth Innovation grant, a partnership between the Microsoft AI for Earth program and The National Geographic Society, is helping Dr. Liberoff's team to automate LULC map production using a transdisciplinary approach. By combining remote sensing data and vegetation indices, the team will produce maps that can then be validated by stakeholders on the ground and used to predict future changes to land and water use.

Mapping the Chubut watershed to preserve resources

The Chubut watershed is located on the arid Patagonian and supports the second most important agricultural valley in the Patagonian region. It also serves as the [main water source for 250,000 people](#). However, due to climate change and warmer, drier conditions, water yield in the Chubut River is predicted to decrease by [20 to 40 percent](#) by the end of the century. Agricultural activities, industries, and urban centers all rely on the watershed, but there is no formal planning for water use.

Water yield in the Chubut River is predicted to decrease 20 to 40 percent by the end of the century.

Monitoring changes to this vital resource can inform responsible management. Mapping land use and land cover (LULC) is critical to modeling human impacts and monitoring and understanding changes to water resources. For the Chubut watershed, a detailed LULC map was created only once, in 2013, by a combination of

visual inspection of aerial photographs and field trips by a local governmental institution—a manual and time consuming process that doesn't allow for frequent updates.

Dr. Ana Liberoff of the Patagonian Institute for the Study of the Continental Ecosystems (IPEEC-CONICET) is working with her colleagues to develop a neural network supported by AI and remote-sensing imagery; this work, combined with citizen science, will automate the creation of LULC maps for the lower Chubut valley. These new technological solutions create consistency and standardization in map creation that can then be shared with public and private stakeholders to inform responsible water resource management.

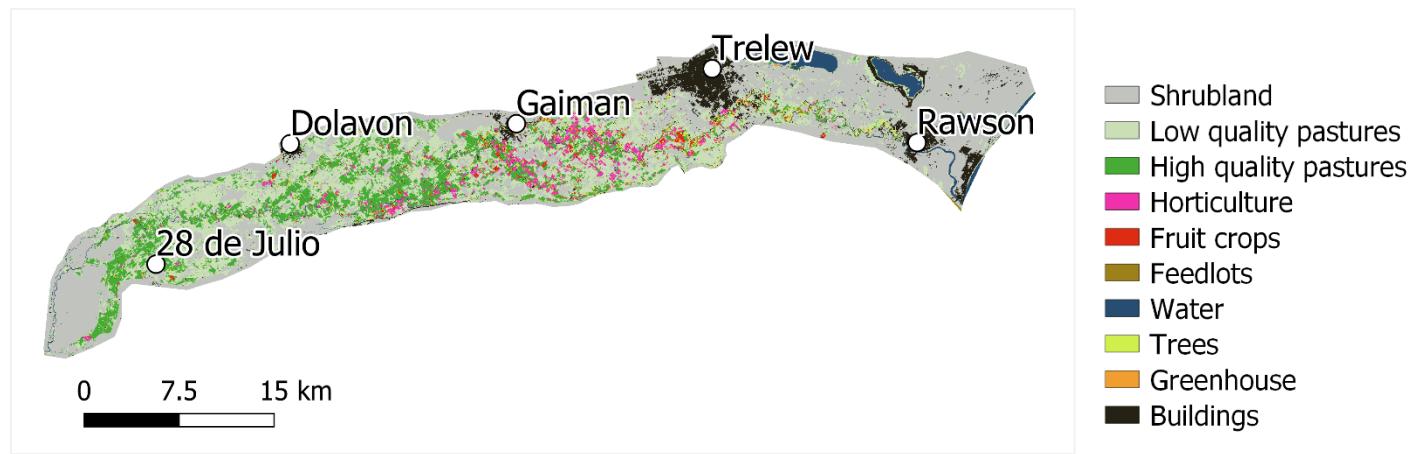
Improving accuracy and speed of map creation

In November 2018, Dr. Liberoff and a team of researchers received their first Microsoft AI for Earth grant; the funding was used to develop a densely connected neural network, "SatNet," that generated a LULC map for 2019 with 83 percent accuracy. With funding from the new [AI for Earth Innovation grant](#), Dr. Liberoff will incorporate data from additional sensors and inputs (including radar imagery and vegetation indices showing ground cover) and automate validation of the maps to create a more complete, accurate, and readily available map of land cover and use configuration in the area. Without this automation, classification of images is a manual process, subject to lack of consistency and long lead times. Dr. Liberoff says, "The virtual machines that we are working with are very powerful, and we couldn't have done what we did without them. The capacity



Biologist Ana Liberoff (center) with colleagues Silvia Flaherty, a remote sensing expert (left), and meteorologist Natalia Pessacq (right). [Photo courtesy Microsoft Argentina]

provided by Microsoft was very useful." Algorithms created from the neural network allow more accurate comparisons of change over time, to predict and address water shortfalls.



*Maps such as this one of the entire Chubut watershed can be used to predict future changes to land and water use.
Image courtesy Dr. Liberoff.*

In order to kick off this new work, Dr. Liberoff and her team will conduct field trips during the crop season of 2021 to validate LULC maps on the ground; this input will help train the machine learning model for future use, allowing changes to be tracked over time. This ground-level work will also help to validate or verify the temporal signature of different crops to create more accurate maps. Dr. Liberoff's team will meet with local water use policymakers to understand potential issues with the methodology, and to learn what information will be most useful to provide to water administration groups and end users.

"We want to get closer to stakeholders and governmental policy makers... Citizen science is a big part of the project."—Dr. Liberoff

Lastly, the group plans to develop a mobile app prototype to let farmers and other water users on the ground verify the land classification data, and ultimately provide farmers with relevant information about local water management issues. "We want to get closer to stakeholders and governmental policy makers to show them the project and the maps, and enhance the maps with their knowledge," says Dr. Liberoff. "Citizen science is a big part of the project."

About Ana Liberoff

Dr. Ana Liberoff is a faculty member at the Patagonian Institute for the Study of the Continental Ecosystems (IPEEC-CONICET) whose work focuses on studying the impact of human activities (livestock, agriculture) on the quality of water in the Chubut River. Her doctorate, earned at the National University of Córdoba, focused on the study of migration strategies in the rainbow trout population of the Santa Cruz River, including stock identification techniques, life history characteristics, and advanced statistical data analysis tools.

Resources

Websites

[Lab EcoFluvial](#)

Publications

Liberoff, A., Flaherty, S., Hualde, P. *et al.* "Assessing land use and land cover influence on surface water quality using a parametric weighted distance function." *Limnologica* 74: 28–37. Elsevier. November 15, 2018.

<https://doi.org/10.1016/j.limno.2018.10.003>

Pessacg, N., Flaherty, S., Solman, S., and Pascual, M. "Climate change in northern Patagonia: critical decrease in water resources." *Theoretical and Applied Climatology* 140: 807–822. Springer Nature. February 8, 2020.

<https://doi.org/10.1007/s00704-020-03104-8>