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Short communication

Harnessing cross-border resources to confront climate change

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ABSTRACT

The US and Mexico share a common history in many areas, including language and culture. They face ecological changes due to the increased frequency and severity of droughts and rising energy demands; trends that entail economic costs for both nations and major implications for human wellbeing. We describe an ongoing effort by the Environment Working Group (EWG), created by The University of California's UC-Mexico initiative in 2015, to promote binational research, teaching, and outreach collaborations on the implications of climate change for Mexico and California. We synthesize current knowledge about the most pressing issues related to climate change in the US-Mexico border region and provide examples of cross-border discoveries and research initiatives, highlighting the need to move forward in six broad rubrics. This and similar binational cooperation efforts can lead to improved living standards, generate a collaborative mindset among participating universities, and create an international network to address urgent sustainability challenges affecting both countries.

1. Introduction

The US southwest and northern Mexico are generally considered to constitute a single ecological and socio-environmental region (Wilder et al., 2013). They share a common history in many areas, including language and culture, and their economies and ecosystems are highly dependent upon one another. They have faced, and continue to face, changes in land use, depletion of fish stocks, ocean warming and acidification, multiple stresses on freshwater, forests, and wetlands, deterioration in air quality, increased frequency and severity of droughts and rising energy demands (Wilder, 2013). These trends entail economic costs for both nations and have major implications for human health and well-being (Garfin et al., 2013).

Proposed policy initiatives by the current US administration affect international climate change agreements, domestic funding levels for environmental agencies, and regulatory controls on cross-border immigration (United States, Office of the Press Secretary, 2017; United States, Office of Mangement and Budget, 2017). These initiatives may overshadow academic collaborations that foster research and educational opportunities, the development of cross-border science, and investments in shared environmental visions, laws, policies and agreements (Lazcano et al., 2017). We argue that successful trans-border, scientific collaborations focused on environmental innovation and advances in knowledge can supersede the tenure of an administration of any country, enhance future environmental innovation, and advance in knowledge from successful scientific collaborations already underway between the US and Mexico.

The La Paz United States-Mexico Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Areas was signed on August 14, 1983 and entered into force on February 16 the following year. Calling for environmental cooperation in the border area based on equality, reciprocity and mutual benefit, this agreement is considered "a stable element of binational relations, institutions, resources, initiatives and reforms" (Mumme and Colllins, 2014). A decade later, both governments created the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADB), which from 1995 through 2014 certified 243 environmental infrastructure projects with an estimated investment of $8.3 billion. Twenty-six projects were related to clean air and efficient energy, and 28 to air quality. Twenty projects were completed by 2014, resulting in new renewable energy capacity that annually displaces 210 thousand metric tons of carbon dioxide emissions (Healy et al., 2014).

In a more comprehensive effort, the United States Environmental Protection Agency (EPA) and Mexico's equivalent agency Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) launched Border 2012, a bi-national network-building program aimed at bringing many previously disparate environmental management efforts into a common framework. Border 2012 brought together federal, state, and local governments, US border tribes, Mexico's indigenous communities, and various other stakeholders in both countries to address environmental

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border issues.

2. Putting cooperation into practice

Addressing the shared, interrelated impacts of climate change requires thinking bi-nationally about the complex issues affecting lives on both sides of the US-Mexico border. This is the goal of the Environment Working Group (EWG) created by The University of California's UC-Mexico initiative in 2015. The EWG assembled binational research teams to understand likely impacts and adaptations to climate change; share findings with decision-makers, governments and the public in both countries; and educate the next generation of US and Mexican leaders to confront binational problems related to a changing environment. EWG teams include representation from all UC campuses and from Mexican academic institutions and organizations, and they encompass more than a dozen disciplines. In 2016/17, the EWG prepared a series of White Papers synthesizing our current knowledge about the most pressing issues related to climate change in the US-Mexico border region. They provide examples of cross-border discoveries and research initiatives highlighting the need to move forward in six broad rubrics: 1) Air and Epidemics, 2) Marine Resources and Fisheries, 3) Freshwater and Agriculture, 4) Terrestrial Biodiversity, 5) Human Vulnerability, Adaptation and Migration, and 6) Drought Impacts on Forests. (http://escholarship.org/uc/search?entity=uc_mexicoinitiative)

a) Air and Epidemics

Human disease epidemics are rising in concert with climate change along the US-Mexico border. The increased emergence of infectious diseases, many of which are caused by fungal pathogens, is of particular concern (Fisher et al., 2012). Human cases of leishmaniosis, Chagas, Zika and Chikungunya diseases due to shifts in sandflies, triatomines, and mosquito populations, also pose important challenges to national public health authorities of both countries. Rates of San Joaquin Valley fever infection have now reached epidemic proportions across the region, owing in part to shifts in drought severity, temperature, and dust loads caused by land-use disturbances. Fungal disease outbreaks can be more challenging to forecast than the spread of other diseases, because fungal pathogen survival is independent of human population density. Up to 40% of those exposed to valley fever spores develop the disease, and mortality rates increase up to 90% in high-risk groups such as individuals with HIV or diabetes mellitus, those undergoing chemotherapy, transplantation, or women in their third trimester of pregnancy. If climate and soil disturbance continue to change, the valley fever-endemic regions could spread, potentially exposing a greater number of humans to the illness (Park et al., 2005), including the 13 million people within the greater Los Angeles area plus the 1.3 million residents in the Tijuana area.

b) Marine Resources and Fisheries

Marine kelp forests provide ecosystem services to humans worth billions of dollars globally (Carr and Reed, 2016). In California (US) and Baja California (Mexico), fisheries associated with kelp forests support economies and societies of coastal communities. Species populations are linked across the US-Mexico border through migration, dispersal, and genetic connectivity (Munguía-Vega et al., 2015). Under climate change the southern extent of giant kelp forest is expected to contract due to warming waters, reductions in nutrients, increasing wave disturbance and grazing by warm-water herbivores. Kelp forests in both countries are currently under stress due to historic overfishing and climate change. In ecosystems shared between nations, such as kelp forest systems, the actions taken by one nation invariably affect the other. Cross border cooperation in the management of these systems could help strengthen their resilience.

c) Freshwater and Agriculture

Rising temperatures and extreme-weather events resulting from climate change will have negative impacts on agricultural production in most of Mexico and the US, particularly California (Lobell et al., 2011; Medellin-Azuara et al., 2012). This will change the ability of both industrial agriculture and traditional farming communities to adapt. California leads the US in agricultural production, valued at $45.3 billion in 2016. It relies heavily on surface water from snowpack and employs a farm workforce that is almost entirely from Mexico. On the other hand, small farmers in Mexico will be the most affected by climate change given their low access to technology, information, and monetary resources to implement adaptive measures (Field et al., 2014). Maize, the major crop in Mexico, is vulnerable to extreme temperature events that are expected to increase in the future. There is evidence that Mexican farmers have already started to implement autonomous adaptation strategies (Monterroso-Rivas et al., 2015) like modifying planting dates, increasing planting density and changing varieties, among other measures. What is not well known is how effective those measures will be, and what kinds of barriers farmers face when trying to adopt them. There is evidence that weather shocks also drive labor out of crop production and out of rural areas in Mexico (Jessoe et al., 2017) and into the US.

d) Terrestrial Biodiversity

The extinction risk for a large fraction of terrestrial and freshwater species will increase during the 21st century due to projected climate change (Settele et al., 2014). Binational research on reptile families along the US-Mexico border is particularly revealing, showing that temperature change has been so rapid that rates of adaptation have not kept pace with climate change (Sinervo et al., 2010). Within the next 50 years, 14% of reptile species in the California-Mexico biogeographic region might go extinct, including three reptiles families endemic to this region. Climate change will devastate biodiversity in the border area unless dramatic steps are taken at a global scale to reduce carbon emissions and at a regional scale to develop new natural reserves. Extinctions may be attenuated by forest cover and by preservation of montane environments in contemporary ranges. By carefully selecting new montane preserves adjacent to desert and tropical forest habitats, and by implementing global controls on atmospheric CO_2 emissions, extinctions may be reduced to fewer than 11% of species and only a single reptile family.

e) Human Adaptation and Migration

Climate change will reduce human welfare, complicate efforts to alleviate poverty and compromise food security and land-based livelihoods during the present century (Field et al., 2014). These factors will stimulate migration out of rural areas into urbanized regions of Mexico and across its northern border. By 2080, climate change is estimated to induce the migration of 1.4 to 6.7 million adult Mexicans (or 2% to 10% of the current population aged 15–65) because of declines in agricultural productivity (Foresight, 2011); the impacts on related non-agricultural sectors could be even larger. Historically, in migrant-sending regions of Mexico, the likelihood of US migration by at least one family member increases in dry years by 40%. Multi-year droughts increase this likelihood by 75%. In contrast, wet years significantly decrease the odds of U.S. migration by 35% (Feng et al., 2010; Hunter et al., 2013). Joint research contributes towards understanding the causes and consequences of migration and how forms of adaptation and investment alter these dynamics.

f) Drought Impacts on Forests

Droughts are expected to increase in duration and severity as the climate system continues to warm at an accelerating rate. Drought impacts on forests of Western North America have been particularly pronounced, exerting several detrimental effects on their ability to provide essential ecosystem services for both natural and human systems (Mantgem and Stephenson, 2007; Anderegg et al., 2012). A major challenge in understanding the regional effects of extreme weather events is our limited ability to scale information from field research plots to larger spatial domains. Studies comparing drought impacts on forests in the Sierra Nevada of California and Sierra Madre Occidental in Mexico using Google's Earth Engine indicate a substantial decline in forest cover over both regions in recent years, a phenomenon that will be further explored in ongoing research.

3. Evolving cooperation

Environmental institutions operating at many levels across California and Mexico provide opportunities to define shared environmental goals, adaptation strategies, and reduced barriers to cooperation on multiple fronts. First, they foster the creation of mechanisms to jointly develop laws, design policies and implement programs and allow the two countries to better pool adaptation opportunities. For example, by working together to map and understand the distribution of fungal pathogens, researchers from the US and Mexico can prepare for—and hopefully prevent—disease outbreaks in the border region. While public health and medical data are difficult to compare between countries, environmental sampling can be conducted across borders and integrated with global climate data. This type of collaboration is a first step towards preventing loss of human life and reducing economic costs of medical treatment.

Second, they pave the way for US and Mexican agencies to coordinate monitoring and data-sharing programs that can be improved if there is an open channel of communication to address opportunities and challenges of binational interest, such as fisheries research for food security. Capacity building is needed to move forward in a coordinated way to address all the issues outlined above as well as other critical issues related to climate change. Agencies could give more support for cross-border programs to provide training, field and laboratory experience to graduate students of both countries, and exchanges for scholars and decision makers. Expanding, coordinating, and integrating physical, ecological, socioeconomic and governance monitoring data will provide a complete vision about how climate change is affecting ecosystems, livelihoods, and environmental policies.

Third, collaborations promote increased flow and exchange of knowledge, competencies, and technologies across the region and among researchers and policy makers. For example, water allocation policies, regulations and infrastructure in California and Mexico were not designed to account for changing climate conditions that will require adaptive and resilient water management in both the US and Mexico (Seager et al., 2013; International Boundary and Water Commission, 2017). Competing water uses for cities, agriculture, hydropower and the environment will require an adaptive and resilient integrated water management approach.

4. Conclusion

Coordinated action among academic institutions, NGOs, government agencies, and voluntary citizen groups on both sides of the border has the potential to tackle the grand environmental challenges of the 21st century. Facilitating exchanges of skills, information, and technologies, and building capacity among the future generation of researchers, educators and decision-makers, can help meet this challenge. The EWG findings are an example of the many potential benefits that joint research and cooperation bring to understanding climate change and designing binational related policies. Its continuation and the emergence of similar efforts could incentivize US-Mexico cooperation in scientific research and policy-making related to climate change and the environment. The EWG can be used as a model of cross-border transformation, to increase regional integration among cities, and to help institutionalize environmental and educational projects for further US and Mexico research integration activities (Broek et al., 2017). This model can generate a collaborative mindset among participating universities (faculty and students) driven by the need to address urgent sustainability challenges, creating an international network for student exchanges, visiting students and faculty, or cross-appointments of faculty (Keeler et al., 2016). Such efforts can lead to improved living standards and cooperative responses to climate change.

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References

Anderegg, W.R., Kane, J.M., Anderegg, L.D., 2012. Consequences of widespread tree mortality triggered by drought and temperature stress. Nat. Clim. Change 3 (1), 30–36.

Broek, J., Eckardt, F., Benneworth, P.S., 2017. The Transformative Role of Universities in Regional Innovations Systems: Lessons from University Engagement in Cross-border Regions. Center for Higher Education Policy Studies (CHEPS) (CHEPS working paper; Vol. 2017, No. 05).

Carr, M.H., Reed, D.C., 2016. Shallow rocky reefs and kelp forest. In: Mooney, H., Zavaleta, E. (Eds.), Ecosystems of California. University of California Press, pp. 311–336.

Feng, S., Krueger, A.B., Oppenheimer, M., 2010. Linkages among climate change, crop yields and Mexico–US cross-border migration. Proc. Nat. Acad. Sci. U. S. A. 107 (32), 14257–14262.

Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., White, L.L., 2014. IPCC, 2014: climate change 2014: impacts, adaptation, and vulnerability. part A: global and sectoral aspects. In: Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Fisher, M.C., Henk, D.A., Briggs, C.J., Brownstein, J.S., Madoff, L.C., McCraw, S.L., Gurr, S.J., 2012. Emerging fungal threats to animal, plant and ecosystem health. Nature 484 (2012), 186–194.

Foresight: Migration and Global Environmental Change, 2011. Final Project Report The Government Office for Science. London.

Garfin, G., Jardine, A., Merideth, R., Black, M., Leroy, S., 2013. Assessment of climate change in the southwest United States: a report prepared for the national climate assessment. A Report by the Southwest Climate Alliance. Island Press, Washington, DC.

Healy, R.G., VanNijnatten, D.L., López-Vallejo, M., 2014. Environmental policy in north america. Approaches, Capacity, and the Management of Transboundary Issues Toronto. University of Toronto Press 224 pp.

Hunter, L.M., Murray, S., Riosmena, F., 2013. Rainfall patterns and U.S. migration from rural Mexico. Int. Migr. Rev. 47 (4), 874–909.

International Boundary and Water Commission, 2017. Extension of Cooperative Measures and Adoption of a Binational Water Scarcity Contingency Plan in the Colorado River Basin. Minute No. 323. https://www.ibwc.gov/Files/Minutes/Min323. pdf.

Jessoe, K., Manning, D., Taylor, J.E., 2017. Climate change and labour allocation in rural Mexico: evidence from annual fluctuations in weather. Econ. J. http://dx.doi.org/10.1111/ecoj.12448. online access 26 JUN 2017.

Keeler, L.W., Wiek, A., Lang, D.J., Yokohari, M., Breda, J., Olsson, L., Ness, B., Morato, J., Segalàs, J., Martens, P., Bojórquez-Tapia, L.A., Evans, J., 2016. Utilizing international networks for accelerating research and learning in transformational sustainability science. Sustaina. Sci. 11, 749–762. http://dx.doi.org/10.1007/s11625-016-0364-6.

Lazcano, A., Ortiz-Ortega, A., Armendariz, S., 2017. Mexican and U.S. scientists: partners. Science 355 (6330), 1139.

Lobell, D.B., Schlenker, W., Costa-Roberts, J., 2011. Climate trends and global crop production since 1980. Science 333 (6042), 616–620.

Mantgem, P.J., Stephenson, N.L., 2007. Apparent climatically induced increase of tree mortality rates in a temperate forest. Ecol. Lett. 10 (10), 909–916.

Medellin-Azuara, J., Howitt, R.E., MacEwan, D., Lund, J.R., 2012. Economic impacts of climate-related yield changes in California. Clim. Change 109 (Suppl. 1), S387–S405.

Monterroso-Rivas, A., Gómez-Díaz, J., Lluch-Cota, S.E., Sáenz-Romero, C., Pérez-Espejo, R., Salvadeo, C.J., Lluch-Cota, D.B., Saldivar-Lucio, R.E., Ponce-Diaz, G., Martínez-Córdova, C., Ramírez-García, G., Baca-Del Moral, J., 2015. Sistemas de producción de alimentos y seguridad alimentaria. In: In: Gay y Garcia, C., Cos-Gutiérrez, A., Peña-Ledón, C.T. (Eds.), Reporte Mexicano de Cambio Climático, vol. II Impactos, vulnerabilidad y adaptación. UNAM, México, México 328 pp.

Mumme, S.P., Colllins, K., 2014. The La paz agreement thirty years on. J. Environ. Dev. 23 (3), 303–330.

Munguía-Vega, A., Sáenz-Arroyo, A., Greenley, A.P., Espinoza-Montes, J.A., Palumbi, S.R., Rossetto, M., Micheli, F., 2015. Marine reserves help preserve genetic diversity after impacts derived from climate variability: lessons from the pink abalone in Baja California. Global Ecol. Conserv. 4, 264–276.

Park, B.J., Sigel, K., Vaz, V., et al., 2005. An epidemic of coccidioidomycosis in Arizona associated with climatic changes, 1998–2001. J. Infect. Dis. 191, 1981–1987.

Seager, Richard, Ting, M., Li, Cuihuav, Henderson, Naomi, Cook, Ben, Nakamura, Jennifer, Liu, Haibo, 2013. Projections of declining surface-water availability for the southwestern United States. Nat. Clim. Change 3, 482–486.

Settele, J., Scholes, R., Betts, R., Bunn, S., Ledely, P., Nepstad, D., Overpeck, J.T., Taboada, M.A., 2014. Terrestrial and inland water systems. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Climate Change 2014: Impacts Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, pp. 271–359.

Sinervo, B., et al., 2010. Erosion of lizard diversity by climate change and altered thermal niches. Science 328, 894–899.

United States, Office of Mangement and Budget, 2017. Budget of the U.S. Government. A New Foundation for American Greatness. Government Printing Office. (https://www.whitehouse.gov/wp-content/uploads/2017/11/budget.pdf, Accessed December 18, 2017).

United States, Office of the Press Secretary, 2017. Statement by President Trump on the Paris Climate Accord. https://www.whitehouse.gov/the-press-office/2017/06/01/statement-president-trump-paris-climate-accord. (Accessed 15 July 2017).

Wilder, B.T., O'Meara, C., Narchi, N., Narváez, A.M., Aburto-Oropeza, O., 2013. The need for a next generation of Sonoran Desert researchers. Conserv. Biol. 27, 243–245.

Wilder, M., 2013. Climate change and U.S.-Mexico border communities. In: Garfin, G., Jardine, A., Merideth, R., Black, M., LeRoy, S. (Eds.), Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment. Island Press, pp. 340–384.