Multi-benefit Conservation Planning for Balancing the Competing Land and Water Use for Agriculture and Biodiversity Conservation

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Introduction

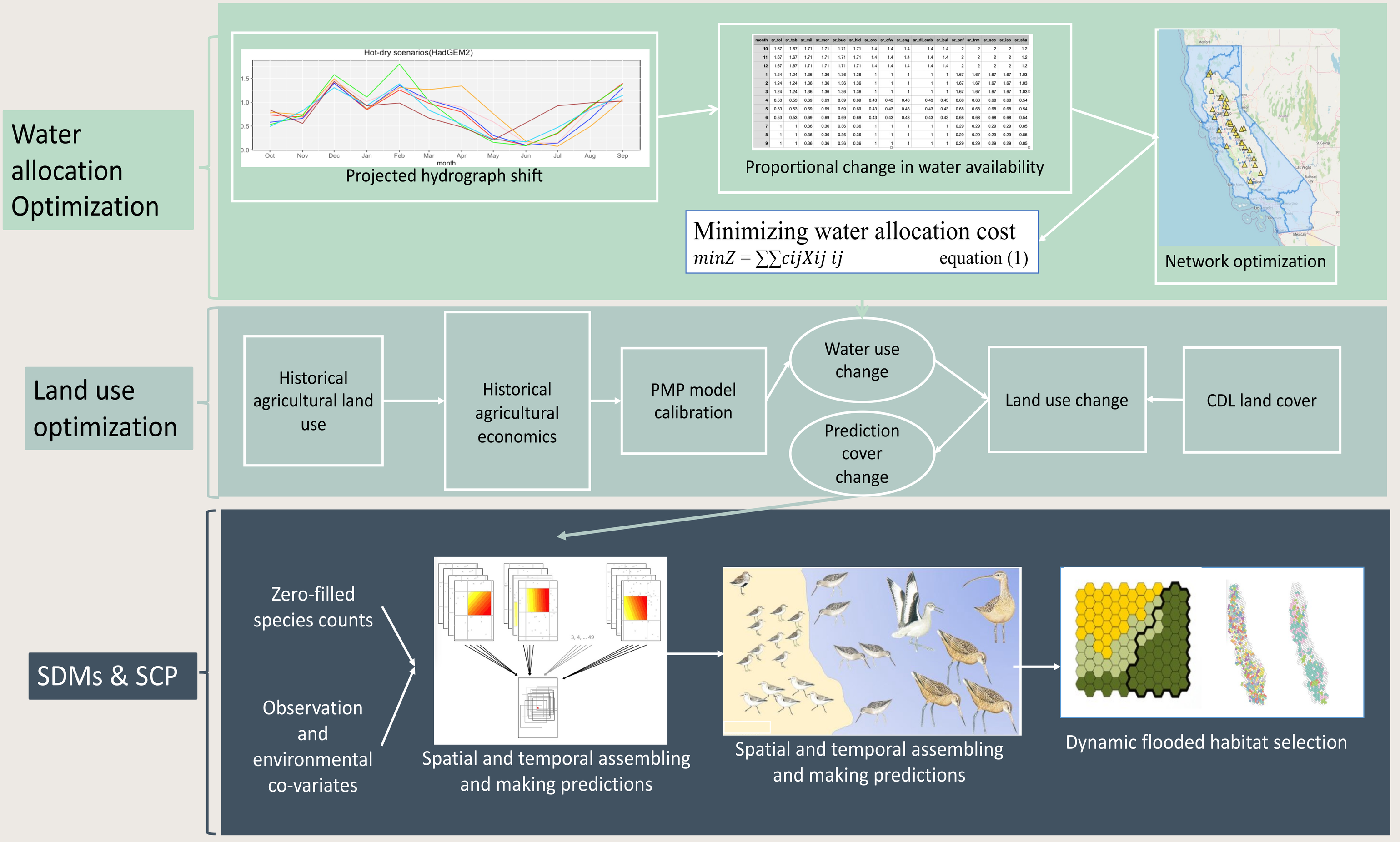
Climate change and land use changes cause ecosystem degradation and loss in biodiversity. The places with high degree of ecosystem degradation usually coincide with places with high economic development. Balancing the conservation resources needed for restoring ecosystem and economic development is critical.

- California's Central Valley, characterized by a Mediterranean climate, hosts the largest agricultural region in the US in both size and value
- 60% Pacific Flyway migratory birds stop here for energy and habitat
- Climate change threatens this highly agriculturally and ecologically productive landscape with water scarcity; Semi-permanent habitat is in shortage by 285,000 acres
- Dynamic habitats on farmlands can balance the land and water uses needed for both birds and farms. The timing and location of dynamic habitats however determines how many birds we can protect using dynamic approach

Research Objectives: This research used integrative geospatial analysis to find right timing and location for dynamic birds' habitats to balance the nature and human needs for natural resources of land and water.

Methods

We synthesized economic optimization, species distribution modelling and systematic conservation planning with.



SDMs: species distribution models, SCP: systematic conservation planning

Results

With climate change, agricultural land and water use will see more volatile changes in year-by-year rice-growing areas. Perennial crops persist in their historical growing areas. Optimized water and agricultural land use resulted in the species distribution of studied birds to the northern regions. Current protected areas are not sufficient for the 30/30 objectives. Dynamic habitats can achieve conservation objectives with only 10% of the cost of the static habitat.

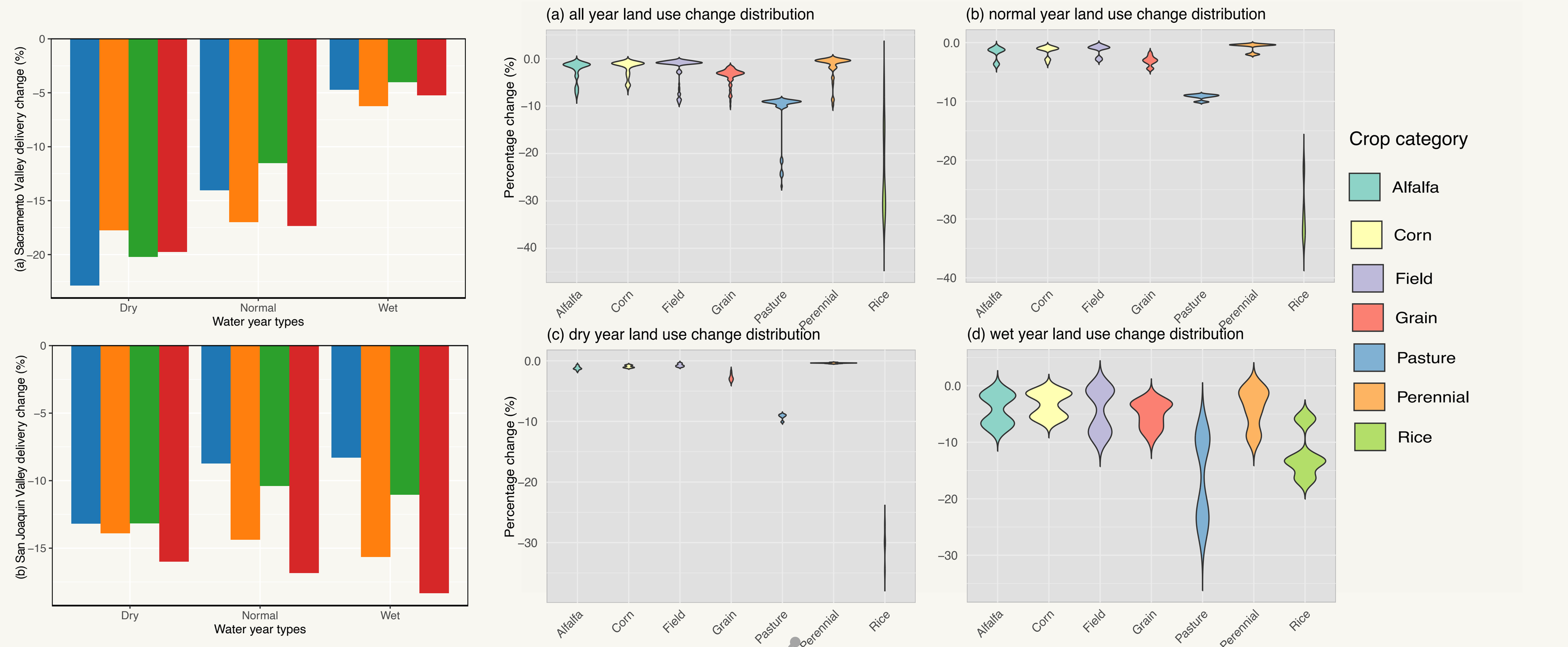


Figure A: Agricultural water and land use change distribution across crop categories and water year types

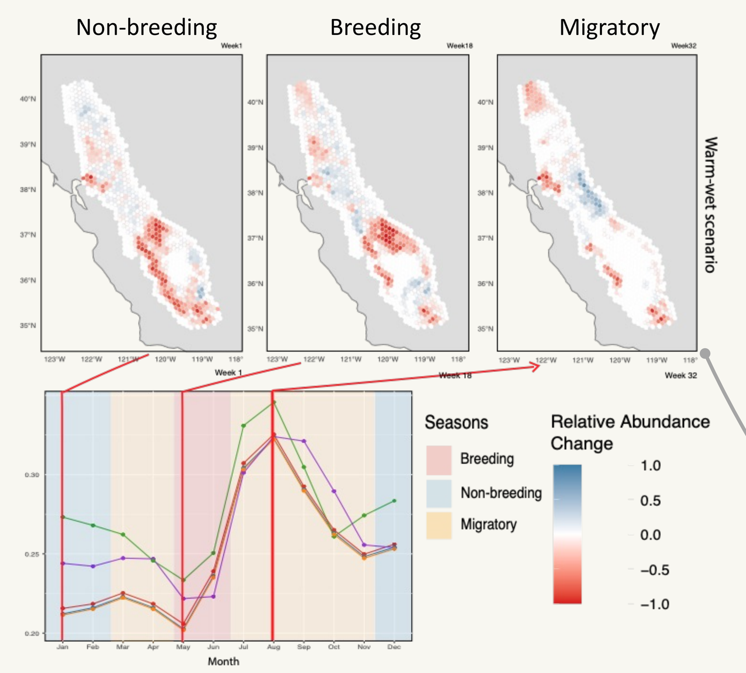


Figure C: Seasonal Black-necked Stilt population change with climate and land use change.

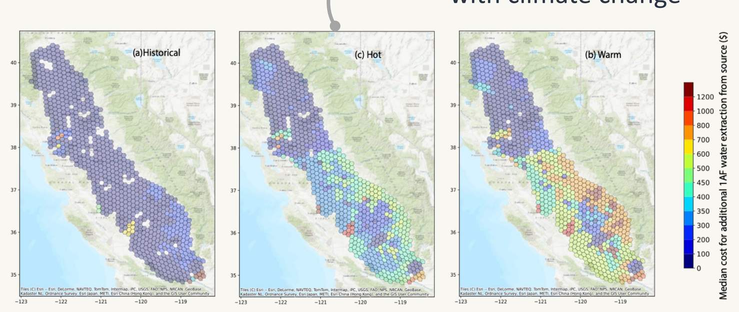


Figure B: Water costs as conservation costs, shifted with climate change

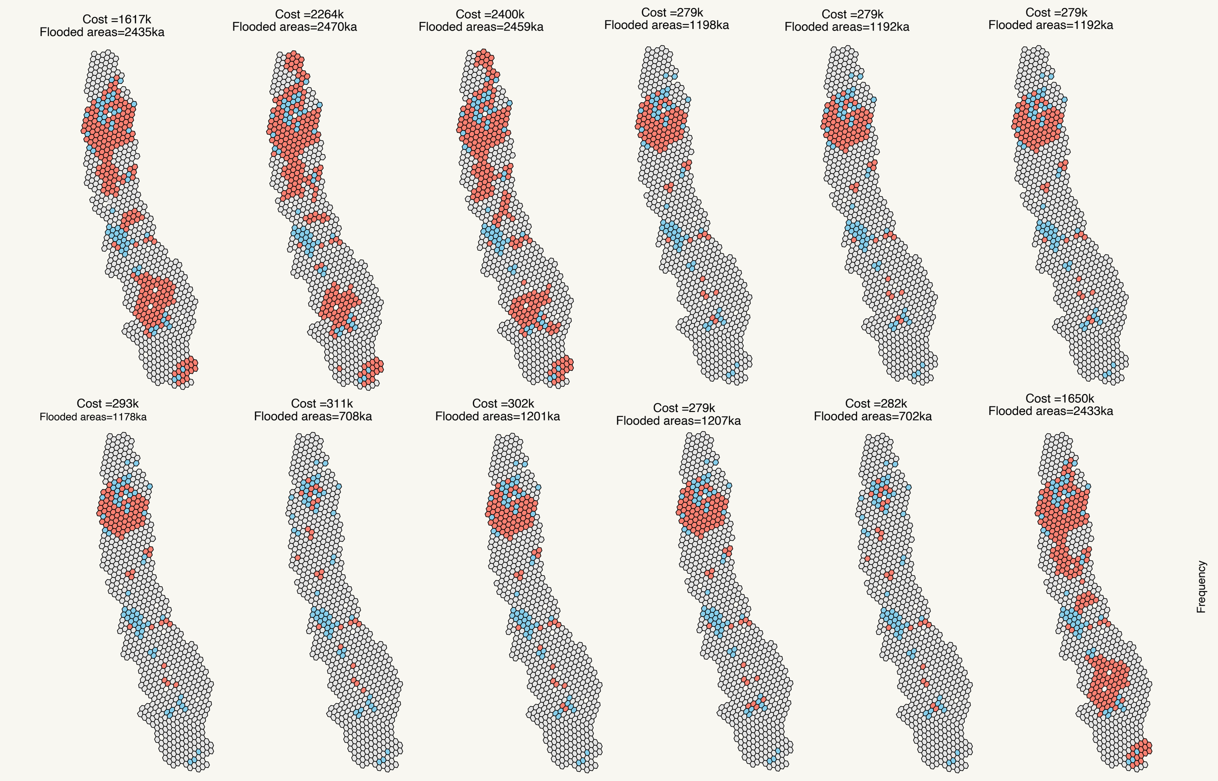


Figure D: Monthly configuration of spatial prioritized flooded habitats with monthly conservation costs

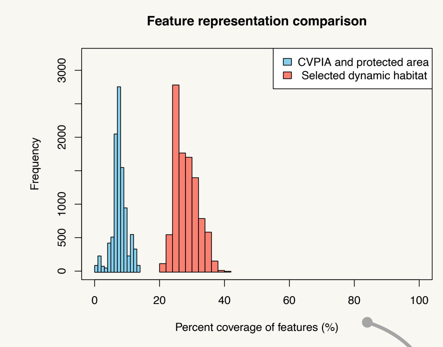


Figure E: Representation of prioritized areas

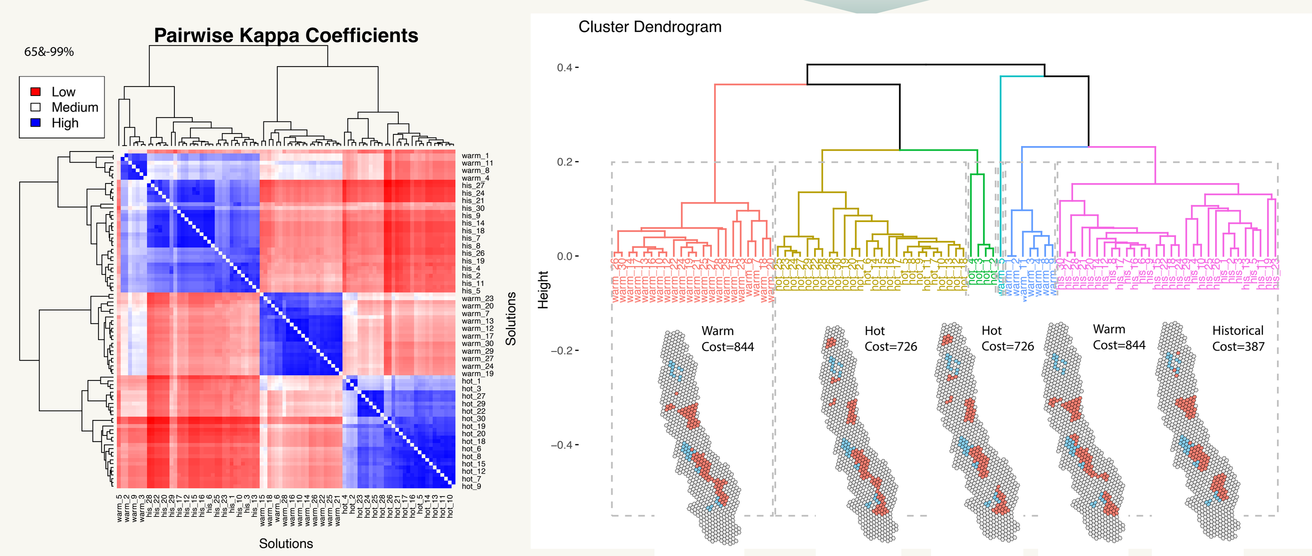
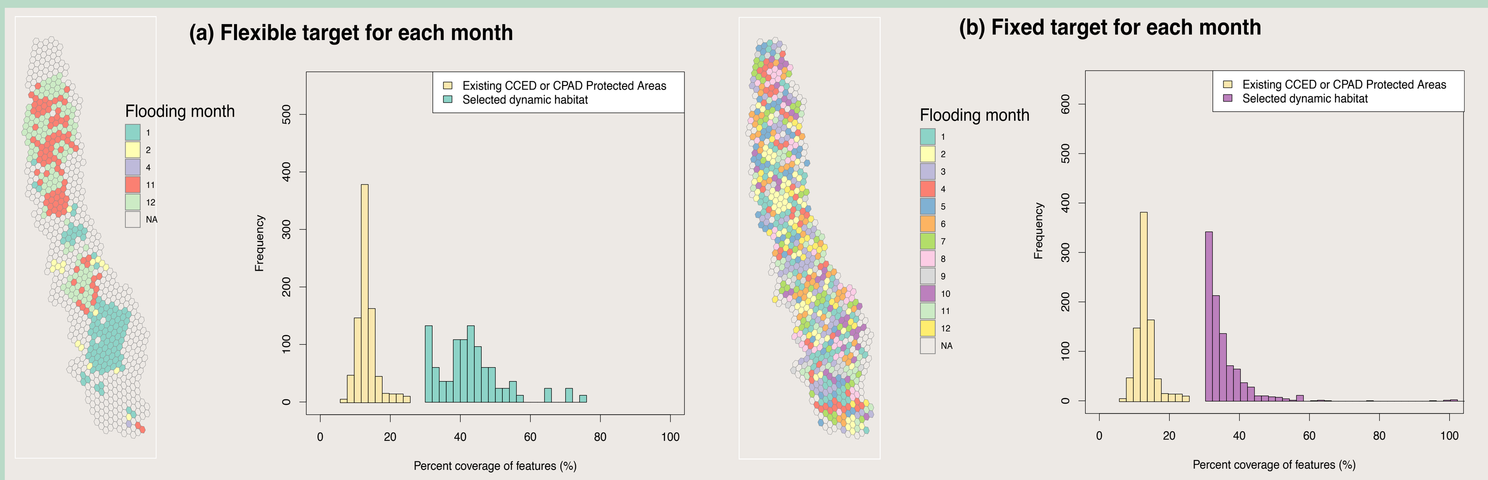


Figure F: Configuration of spatial prioritized flooded habitats with climate change, climate change affects the required connectivity in habitats

We estimated the static habitat prioritization would cost around a thousand million dollars annually. Dynamic habitat, however, only costs one hundred million dollars a year for the same objectives

Discussion



Trade-offs between conservation efficacy and cost

If we fixed the targets achieved over different months, cells with high conservation value although not economically viable were also selected.

Co-benefits between agriculture production and conservation

Dynamic habitats can achieve dramatic cost savings as the cost of water and land are considered and the avoided conflicts with agriculture.

Species range shift change conservation timing and location

Climate change will change the spatial configuration of prioritized areas because of the species range shifts and the spatial variation in water costs.

Conclusion

This integrative conservation planning research showed us how to adapt to climate change by considering the benefits to both humans and nature. Climate change will fundamentally change landscape features with the changing water availability. This change will result in species change.

The findings suggest that the dynamic habitat approach can be an excellent viable climate change-adapt conservation approach that changes spatial prioritization across space and time with cost savings. Quantitative studies like this research will provide the information required for strategic planning in changing environments.

About Us

Liying Li (lli@nceas.ucsb.edu) is currently a postdoc researcher at the NCEAS of University of California, Santa Barbara. She graduated with her PhD degree in the Environmental Systems from University of California, Merced. Professor Josue Medellin-Azuara and Professor Joshua Viers supervised this research. In line with Liying's interest in quantitatively assisting decision-making in climate change adaptation and environmental policies, she conducted this synthesis research, aiming to assist dynamic habitat creation in California. Now she is studying climate change impacts on the birds in the Gulf of Mexico with the advancement of Artificial Intelligence for the NOAA Golf of Mexico Initiative (GEI) program. Please scan barcode for more information on GEI program.