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Approaches of Integrated Hydrologic Modeling for Water Resources Management in Chilean Basins

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ABSTRACT

Introduction:

Within the comprehensive management of watersheds, the numerical modeling of water flows is a fundamental aspect in the development of these types of projects, allowing for the representation of physical phenomena within the basin and the historical and projected demand for water resources. In recent years, modeling approaches have been focused on establishing a direct link between groundwater and surface water models. This approach enables a better understanding and representation of the dynamics of water resources, both from the perspective of water balances and their surface interaction with aquifers, as well as the comprehensive management of watersheds. In this regard, planning and comprehensive watershed management strategies were evaluated and designed through integrated simulation models of surface and groundwater in some basins in Chile with different climatic conditions, exploitation levels, and availability of information. These strategies were applied in arid watersheds in the northern region (where the focus of modeling is the appropriate underground representation), watersheds with extensive agricultural exploitation in the central zone (presenting significant intervention in both aquifers and surface waters), and watersheds located in southern regions (with cross-border characteristics), thus representing different challenges and approaches to integrated modeling.

Methodology: Each strategy for watershed planning and comprehensive management considered two alternatives for the representation of physical processes and their corresponding spatial representation of the study area. Alternative 1 corresponding to integrated and directly linked models using the computational platforms WEAP and MODFLOW, or alternative 2 corresponding to independently integrated models in each computational platform according to the limitations that existed in each case. Thus, the modeling strategy was adapted to the needs of each watershed, identifying the best alternative to represent the complexity of the evaluated water system. Finally, once an adequate representation of the behavior of the basin was achieved, the management of water resources was evaluated through future scenarios that consider climate change. Figure 1 shows the watersheds where this methodology has been implement following one of the two approaches.

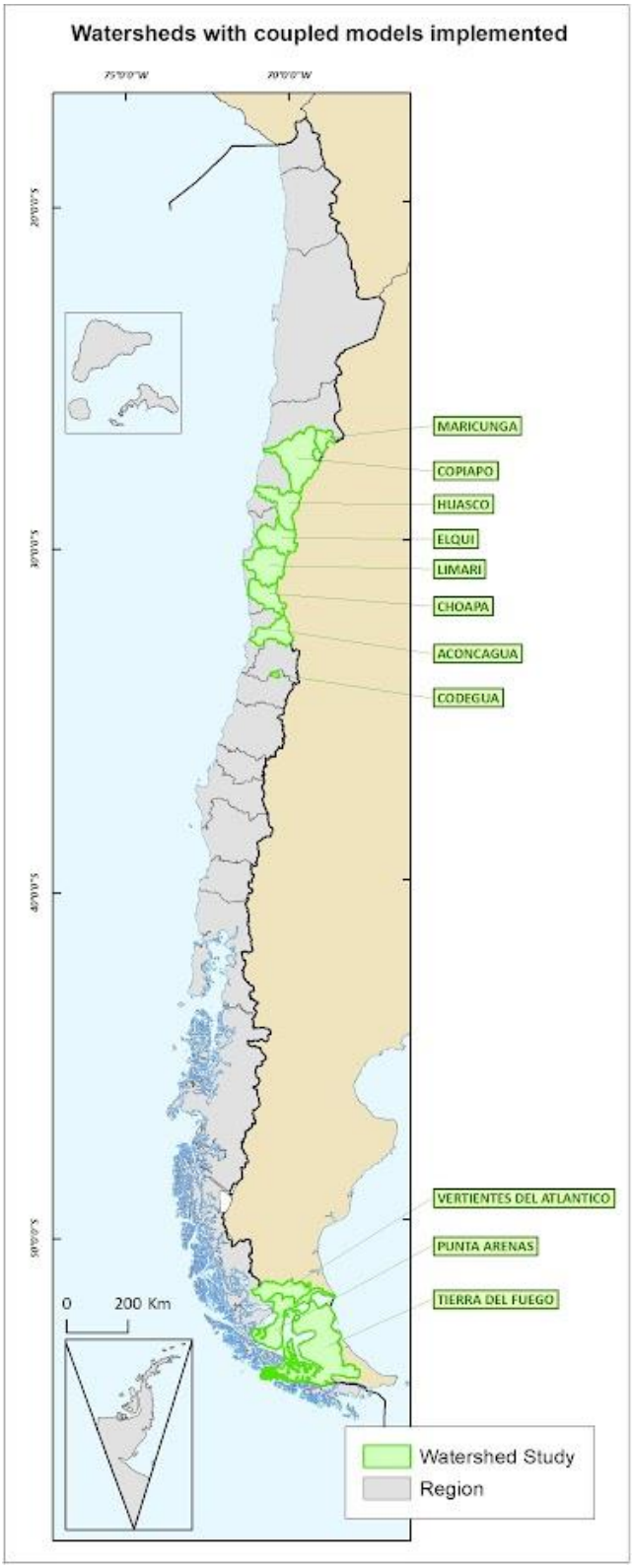

Figure 1 Watersheds where methodology has been implemented

Results and Conclusions: Although the different watersheds were initially analyzed with the vision of applying modeling alternative 1, the particular characteristics of each one showed that modeling alternative 2 is more suitable for representing certain issues that require greater spatial detail or more complex underground modeling tools. By adapting the modeling methodology to the reality of each watershed, it was possible to obtain more precise and realistic results in complex situations, both for the representation of surface and groundwater systems and for the planning and comprehensive management of the watershed. This was of great use in establishing policies and actions related to the management and use of water resources for decision-makers. Finally, the experience gained in the development of different models throughout the country showed that it is possible and necessary to apply different integrated modeling approaches that can adapt to the reality and available information of each watershed, but also achieve the goal of a comprehensive watershed evaluation, obtaining satisfactory results in different climatic contexts.

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