

## Integral Approach to Historical Interaction between Human Activities and Hydrological Cycle in Dryland

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This article proposes an alternative approach in sustainability assessment. The conceptual framework was developed by modifying Ken Wilber's All Quadrants, All Levels (AQAL) approach. To look at how our framework can facilitate the practice of sustainability assessment, we apply the framework to examine interaction between humanity and environmental changes in the Heihe River basin.

Historically, nomadic grazing was practiced in the arid areas of the basin and agriculture was practiced in the water-rich oases. Since the 1940s, however, large-scale development has been carried out for irrigation agriculture. However, the large-scale irrigation agriculture dried up the river and caused groundwater level decline in the lower reaches. In the 21st century, the Chinese Government has implemented water saving policies. The policy proposed several water efficiency measures, such as restriction of river water intake, more efficient water supply, introduction of more water-efficient crops, and prohibition of the reclamation of new farmland. However, problems have since emerged, such as disparity in the efficiency of water use attributed to economic inequality among farmers, a decrease in the groundwater recharge due to irrigation, and water saved by farmers being diverted to farmland newly reclaimed by agricultural corporations. It was reported in July 2002 that water had returned to the dried-up terminal lake of the river. Water balance analysis shows an increase in river discharge released to the downstream, but this was due to greater rainfall in upstream reaches. On the other hand, in downstream reaches where livestock farming has been practiced, vegetation conservation policies have been promoted, such as fencing of riparian forests, "ecological migration," and construction of feed bases. On grazing land, biomass has increased as a result of declining grazing pressure; and has also increased in the downstream areas as a whole, but due to farmland development and plantations rather than as a result of these policies.

The history of human/ecological interactions in the oases of the Heihe River Basin indicates that water deficiency resulting from increased human activities has traditionally been solved by sourcing water from outside the living sphere of the local people. In other words, people have solved the problem by expanding their system boundaries. It would be no exaggeration to say that advancements in civil engineering and other technologies have enabled this. However, globalization has expanded the current system to the limits of the closed system we call the Earth. Historically successful methods can no longer be used, and limiting our efforts to simply pursuing efficiency would only create new problems. It therefore is crucial to find new solutions.

The proposed approach enables us to investigate the environmental problems of the Heihe River basin in a four-quadrant framework, and combine the empirics of quadrants obtained from traditional disciplinary methodologies. The four-quadrant framework adopted in this study illustrates the interlocking relationships among various perspectives of environmental issues in the Heihe River basin, namely, physical perspective, personal perspective, cultural perspective, and social perspective. In particular, the protruding development (evolution) of the lower right dimension is the fundamental cause of the environmental degradation and its related social problems in the Heihe River basin. Compared to other established approaches in literature that emphasize on the tradeoffs of various perspectives of sustainability, our findings indicate the potential contributions of four-quadrant framework to sustainability assessment through its focus on the inter-relatedness/inter-connection of different perspectives.

**Keywords:** AQAL, Integral Studies, Sustainability assessment, Irrigation agricultural development, Water resources management, Culture