Water management policies for the algal biofuel sector in the Southwestern United States

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Abstract

Algal biorefinery-based integrated industrial ecology has received increased attention as a sustainable way of producing biofuel, food, high value products and feed ingredients in the Southwestern United States (US). However, these regions already face serious freshwater supply issues. Hence, new policies and regulations for water management and use is a high priority for the sustainable development of an algal biofuel sector to meet liquid fuel needs in the US without hampering the regional hydrologic pattern.

1. Introduction

Algal biomass production offers several advantages over conventional terrestrial biofuel feedstocks. Algae offer significantly higher biomass and lipid yields per acre per year [1], economic use and recovery of waste nutrients [2], use of non-potable water such as saline, brackish, industrial or municipal waste water, productive use of non-crop lands (desert, arid and semi-arid land) [3] and capture of CO₂ from power-plant flue gas, cement or other manufacturing plants, breweries or other carbon sources [4,5]. These positive sustainability indices have attracted substantial research investments from federal government, private investors and energy industries into this sector as a sustainable way of producing next generation biofuel, food, and high value products [6,7]. The recent National Algal Technology Road Map by United States Department of Energy identified Southwestern states are optimal for future algal biofuel sector [8]. Similarly, a ‘renewable energy corridor’ rich in the multiple energy sources needed for algal biofuel production via the deployment of Integrated Renewable Energy Parks has been envisioned in the Southwestern (SW) US [9–11]. This corridor, comprised mainly of regions of New Mexico, Arizona, and Colorado, is poised as an optimal region for algal biomass generation because of the availability of the necessary natural resources such as sunlight, an optimum ambient temperature, cheap arid land and saline water [6,8]; however, some of these regions face major freshwater issues.

2. Water resources in Southwestern United States

The upper and lower Colorado basin and the Rio Grande River basin are the main surface water resources in the corridor area. The Colorado River and its watershed (242,900 square miles) is the major source of water for irrigation, drinking, and other uses by people living in the arid SW States [12]. Since the completion of several dams (e.g., Glen Canyon Dam, Hoover Dam, Imperial Dam), the majority of the river has been diverted for agricultural irrigation and municipal water supply. Several cities have aqueducts leading all the way back to the Colorado River. Similarly, the Rio Grande River and basin mainly provides surface water resources to regions of lower Colorado and to the entire state of New Mexico. Several fresh and saline ground water resources (~5 billion acre-feet of brine water) are contained within several aquifers in this corridor. Although not complete list a brief summary of the major fresh and saline aquifers in the SW US is listed in Table 1. The surface and ground water resources are already being used extensively in this corridor region.
### Table 1

<table>
<thead>
<tr>
<th>Aquifer</th>
<th>Geographic region and characteristics</th>
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<tbody>
<tr>
<td>Albuquerque Basin</td>
<td>The Albuquerque Basin covers about 2100 square miles of central New Mexico. The basin was formed by tectonic events in Pennsylvanian–Permian time, Jurassic–Cretaceous time, and events in Oligocene–Recent time associated with opening of the Rio Grande Rift. Recharge enters the Santa Fe Group sediments by surface water infiltration, mountain front recharge, and as ground water flow across the northern boundary of the Albuquerque Basin.</td>
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