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Mini Review

Continental Shift: Agricultural Shift to the Unsuspecting Laurentian Great Lakes

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Abstract

The purpose of this paper is to provide a brief expose of the imminent massive transition of agriculture in the USA to the Great Lakes region. This vignette uses empirical data on water stress, mapped using Geographic Information Systems (GIS), and discusses the status quo of high volumes of water-intensive crops being grown in water-stressed regions of the USA. It posits that the current unsustainable practices, exacerbated by the increasing frequency and severity of droughts, will result in a massive transition of agriculture to the Great Lakes. This imminent transition is surprisingly unsuspected in the Great Lakes region: it is noticeably absent from future planning, absent from risk and resilience planning, and the region does not have sufficient policies in place to manage this influx; including the intense increase in demand for chemical pesticides and fertilizers, and the increase of pressures on its vast but fragile freshwater resources.

A continental-scale shift in agriculture is coming to the unsuspecting Laurentian Great Lakes. As water scarcity and water consumption increase diametrically, and droughts increase in frequency and severity, significant segments of the USA agricultural production system are no longer sustainable or viable. For example, "500-year" droughts are occurring on average every four-five years, and the most recent "500-year" droughts were in California and Texas, two of the USA's largest food producers. The USA is now facing a "1200-year" megadrought, which many hydrologists and climatologists indicate could subject the entire American West to extreme drought conditions across 70% of its land; and it could last at that level of severity for 20 years [1].

Baseline Water Stress of the United States

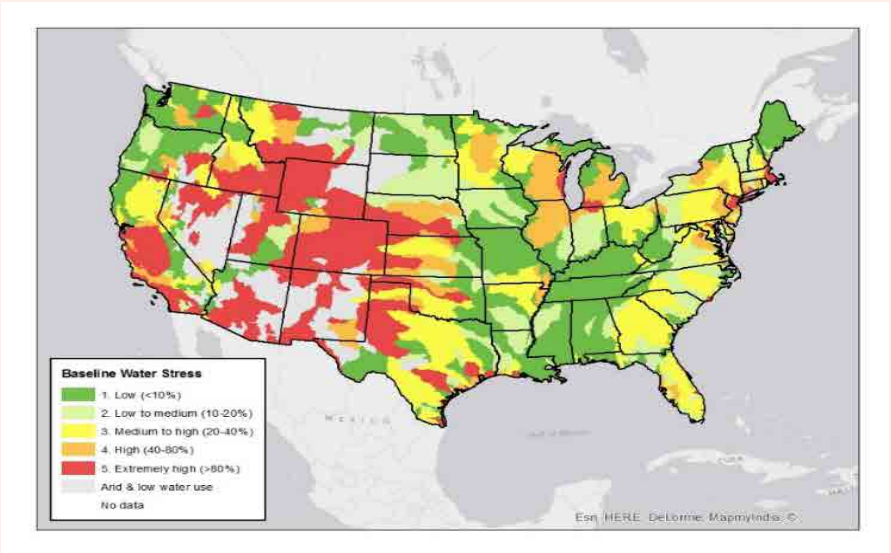

Figure 1: Baseline Water Stress Map of the United States. The measure of water stress is a ratio of water availability and water consumption. The data is sourced from U.S. Geological Survey National Water Information System [2].

As drought conditions worsen, addressing water scarcity in agricultural regions becomes more urgent; water scarcity disrupts food supply chains, results in exporting tremendous amounts of water-intensive crops out of dry regions, skyrockets food prices, increases energy dependence and increases energy costs in agriculture in order to move irrigation water across vast distances and pump water up from great depths. Thus further depleting the rivers and aquifers. In the USA, agriculture is the largest water user, requiring approximately 70% of all water used in the US for human production and consumption [3]. Approximately 300 billion gallons of freshwater are withdrawn daily from surface and ground water sources for agricultural irrigation in the United States [4]. Agriculture is also one of the largest economic sectors of the US: Agriculture generates over USD 60 billion per year for the U.S. economy [5]. Yet, agricultural insecurity is worsening at an unprecedented pace, largely as a function of water-intensive crops being grown in water-scarce regions.

A little-known distortion in the USA agricultural system is that many of the most water-intensive crops are grown in the most water-scarce regions [6]. The most severe problems are evident in the American West, Southwest, California, Texas, and Great Plains. Those regions produce most of the country's grain; particularly, water-intensive wheat, corn, and soybeans. For

perspective on the magnitude of problem in grain production, the USA is the largest grain producer in the world, and the majority of this grain grown in the most water-stressed regions of the country. For this reason, the mighty rivers such as the Colorado River and expansive aquifers such as the Ogallala Aquifer being depleted at non-renewable rates. When the ecosystem services of these rivers and aquifers collapse, and the severe water stress in the America West, Southwest, and Great Plains exposes that large-scale agricultural production in those regions is no longer viable, which is imminent, agriculture will shift to the Great Lakes region for its vast freshwaters.

The Laurentian Great Lakes, located between the USA and Canada, are the largest surface freshwater resource in the world, constituting 25% of the world's surface freshwater [7]. In the USA, the Great Lakes hold 85% of all the surface freshwater in the country [7]. The economic value and restoration value of the ecosystem services of the Great Lakes have been estimated by the Brookings Institution's Great Lakes Economic Initiative to have a direct economic benefit of $50 billion in long-term benefits and $30-$50 billion in short-term multiplier benefits [8,9]. The restoration value of the Great Lakes is over $100 billion in economic benefits [8,9]. The US Federal Government has allocated approximately $300millionUSD per year to protect and restore the Great Lakes freshwaters and ecosystem services. There have been many years of unusual bipartisan congressional support for these allocations to the Great Lakes Restoration Initiative (GLRI), which administers the $300million. However, the recent former executive administration proposed a 97% cut in the GLRI funding, which dismissed efforts to address climate change in the Great Lakes and resulted in the ongoing degradation of freshwater water resources m the lakes.

The shear vastness of the Great Lakes has led to the fallacy that they are not fragile. The empirical reality is that the lakes are approaching critical environmental tipping points in extraction, consumptive use, pollution and degradation, as well as climate change and vulnerabilities that are jeopardizing the lakes' ecosystems through unprecedented increases in water temperatures, evaporation, toxic run-off into the lakes and the increased uptake of toxic materials by organisms in the lakes [10]. The degradation of water quality and quantity due to consumptive use, pollution, and climate change has already altered the capacity of the Great Lakes region to produce agriculture, decreased the capacity to generate energy, and exacerbated environmental stressors. However, these water and environmental stressors pale in comparison to the extreme water stress of the American West, Southwest, California, Texas, and the Great Plains. With the looming collapse of agricultural viability in those regions, compared to the abundant albeit fragile freshwater of the Great Lakes, the Great lakes region should prepare for a massive agricultural transition to the Great Lakes for their abundant freshwater [11].

There are insufficient agricultural policies in place in the unsuspecting Great Lakes States to manage this continental-size shift in agriculture to the region specifically to extract its water resources. In addition to the intensification of demands on the water and soil, the increased growing season due to increasing temperatures from climate change, will also result in an increased use of chemical pesticides and fertilizers, which will render most of the water used in intensive industrial-scale agriculture to be consumptive use, meaning the water is not returned to the hydrological system or it is returned as run-off that is highly polluted with animal waste or toxic chemicals. Although there are many individuals, groups, and businesses that are working on environmental conservation and restoration of the Great Lakes, there is little, if any, attention or information on the imminent large-scale transition of agriculture from the water-stressed, drought-stricken regions of the US, which are now facing 500-year droughts several times per decade and entering a 1200-year drought. Agriculture in these drought-stricken regions, in addition to their long history of over extraction of rivers and aquifers, has already proven to be unsustainable, and it will soon prove to be unviable, which will increase the volume and velocity of the transition of to the water-rich, albeit fragile, Great Lakes region. To manage this massive transition, agricultural and water-use policies need to provide incentives to grow crops based on water-use efficiency, increase the use of drought-tolerant crop species in water-stressed regions, reserve production of water-intensive crops for water-abundant regions, compensate growers for fallowing fields in severely water-stressed regions, improve irrigation techniques and expedite the advancement and implementation of technologies to increase water-use efficiency. If the imminent massive agricultural transition and increasing intensity of production expedites the degradation of the freshwaters of the Great Lakes, it would jeopardize the capacity of agriculture to continue to thrive and prosper in the region, which is antithetical to reason agriculture is shifting there. It would degrade the very freshwater assets it moved there to employ. For this reason -the predictable tragedy of the commons- it is crucial to put policies in place to manage the continental-scale shift and the impending growth in the agricultural sector, not to derail it completely, but to moderate and mitigate it, plan for it, and ensure that it be sustainable.

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