"Cotton Biomass Society" — Learning Lessons from Uzbekistan —

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Climate and Vegetation

It goes without saying that the climate exerts dominant control over the spatial distribution of major vegetation types on a global scale. In turn, vegetation cover affects climate via the alteration of the physical characteristics of the land surface through the albedo[1], roughness[2], and the amount of biomass present. Some simulation models reveal multiple steady states[3] in many regions due to a strong interaction between the vegetation[4] and hydrological cycle[5]. My own background is in hydrology and civil engineering and at present, I am working on the sustainability of large scale tree plantations in the peat swamp forests of Indonesia. In my previous work, I developed a hydrological circulation model of the Huaihe River basin in China, the Aral Sea basin in Central Asia, as well as working on peat swamp forests in Indonesia (Kozan et al. 2003, Kitamura et al. 2007). What my continuous research has clarified is that an estimation of the impact of the land surface on heat and the hydrological cycle is important for both water resources management and climate change analysis. In this short essay, I focus on what forms of biomass society exist in Uzbekistan. I draw upon the methodologies that I have developed within sustainable humanosphere studies I have conducted in Southeast Asia and East Asia. What I aim to show in this essay is what mistakes were made in Uzbekistan and the lessons that can be learnt from this in the development of biomass resources for human survival and sustainability in tropical Southeast Asia.

Biomass is usually defined as the biological material made up of living or recently living organisms, most often referring to plants or plant-derived materials. Over mankind's history, we have continuously appropriated biomass resources from local vegetation, rice, being a prime example in Southeast Asia. Rice, requires intensive irrigation and in previous studies I conducted in the Huaihe river basin, it was clear that since the 1950s, many water facilities like irrigation channels and water reservoirs were constructed specifically for rice and crop cultivation. As such, land and water use related to rice and other crop cultivation promoted the local and regional hydrological cycle during cropping seasons in the Huaihe river basin. The hydrological conditions, including water facilities, maintained multiple steady states in the area over a prolonged period of time. However, in some cases, human activities led to irreversible environmental destruction and hydrological change. I focus on Uzbekistan to further discuss the impact of human activities in relation to monoculture biomass society.

Fig. 1: Basins of the Syr Darya River (based on the NASA World Wind (2005)

"Cotton Biomass Society" and the Shrinking Aral Seas

Uzbekistan, formerly part of the former Soviet Union, is the largest Central Asian cotton producing republic in the region. Under Soviet rule, cotton was intensively produced and this inevitably led to the depletion of the Aral Sea, and exacerbated salinity problems. Intensive commodity based production created a region almost totally dependent on a single agricultural commodity, despite riches in terms of petroleum, natural gas and precious metals.

Two major rivers – the Syr Darya and the Amu Darya – originally flowed into the Aral Sea, once an inland lake that was the world's fourth largest in water area. In the 1960s, the Soviet Union started large-scale irrigation projects in the vast dry steppes extending through the mid and downstream basins of these two rivers. Irrigated land grew from about 4.5 million hectares (ha) in 1960 to about 7 million ha in 1980. During these two decades, the population roughly doubled from 14 million to 27 million, as did the amount of water taken from the rivers, from 64.7 km^3 to 120 km^3 – over 90% of which was used for irrigation. By 1999, irrigated farmland occupied 7.90 million ha and water taken from the rivers ranged from 110 to 117 km^3. The main crops promoted for consumption were water-hungry – cotton, rice, wheat, maize, and grass. As a result of the rise in consumption, a huge increase in water diverted to irrigated areas dramatically decreased water flowing into the Aral Sea, disturbing the balance between water inflow and evaporation from the lake. Sadly, this drastically reduced the lake area and rapidly raised the saline concentration from 10% to 35%. The Aral Sea became divided into two parts: the Small Aral in the north and the Large Aral in the south, both of which continue to shrink

It was during the Soviet Era under the Soviet Union's "planned economy" policy, that many dams and other irrigation facilities were constructed in the Syr Darya basin, due to the Communist Party's prioritization of cotton cultivation in downstream Uzbekistan and Kazakhstan. That was because most of the socialist countries were located at a high latitude and only Uzbekistan possessed the high potential to cultivate cotton biomass for clothing. Many water facilities, including the huge multi-purpose Toktogul Dam, were built in Kyrgyzstan, located furthest upstream in the basin and rich in water re-

sources. This put several thousand hectares of fertile land and many rural communities and historically important sites under water. These water facilities were used to supply the two downstream nations with irrigation water rather than to produce electricity. About 75% of the annual discharge released for irrigation downstream in the summer months of April to September (Abbink et al, 2005). The Soviet government "compensated" Kyrgyzstan for its lost water and efforts exerted to operate and manage irrigation facilities by supplying coal, petroleum, gas, and other energy resources abundant in the two downstream republics to Kyrgyzstan in addition to preferential budgetary measures. However, large-scale irrigated agricultural production promoted in Uzbekistan and Kazakhstan caused secondary environmental problems. This included the continual shrinking of the Aral Sea. However, the Soviet government avoided competition for water use among the republics in the basin by redistributing resources throughout the Soviet Union under Communist Party control. Thus, cotton biomass production became the top priority in this area during the Cold War period.

Climate Change Induced by "Cotton Biomass Society"

In addition to the impacts of water management changes on water circumstances in the basins, human activities also changed the regional climate. Meteorological data[6] shows that the Aral Sea basin experienced strong temperature warming over the last 30 years, melting snow earlier in spring and causing water shortages in summer. Some local researchers reported extensive land cover changes caused by both human impact and temperature warming.[7]

For example, data provided by the Carbon Dioxide Information Analysis Center (CDIAC) and other local researchers[8] showed that air temperature warming averages over a 100 year period were 0.9-1.0 degrees yet 0.4-0.5 degree for 25 years in Uzbekistan. These values are relatively higher than global averages, e.g., those reported by the Third Intergovernmental Panel on Climate Change (IPCC) who presented 0.6 degree for 100 years (1900-2000). Precipitation data from 25 stations in the area showed a positive trend in precipitation and 24 showed positive (increasing) trends in air temperature. No marked trends were seen for precipitation, but only one station indicated negative trends.

Post-Soviet Biomass Society

After the break-up of the Soviet Union, Uzbekistan gained independence in 1991. Cotton was formerly absorbed largely by the industries of Soviet and COMECON countries and distribution was predominantly controlled by Moscow. On independence, as the old regime crumbled, the country had to suddenly find new markets. Industrial output in the former empire collapsed, and the new government had to establish itself in world economic affairs. Furthermore, there was a move to wean the nation off the monoculture of the Soviet period and achieve self-sufficiency in grains. This, together with water constraints, has resulted in a declining trend in areas devoted

Pict. 1: Cotton is picked by hand mainly by women, and including child labor.

to cotton, from over two million hectares in the late eighties to around 1.43 million in 2008/2009.

In 1992, Uzbekistan and other independent Central Asian republics concluded the Almaty Agreement emphasizing downstream irrigation and environmental issues, all disadvantageous to upstream water distribution. Essentially, the agreement maintained the irrigation policies implemented under the Soviet era's planned economy, but disregarded upstream economic development using water resources. The two downstream republics used water from Kyrgyzstan for free irrigation and started selling energy resources to be supplied to Kyrgyzstan on the world market. This left Kyrgyzstan with the maintenance costs of its cascaded dams while being charged international prices for gas, coal, and petroleum exported from downstream. In the summer of 1993, Kyrgyzstan decided to use the Toktogul Dam, - the largest in the basins, with a reservoir capacity of 19.5 billion m^3 and an active storage capacity of 14.5 billion m^3 -, for power generation in winter. Kyrgyzstan reduced summer water release to 45% of the annual discharge and increased winter release to 55% in October to March during the 1990s. This triggered a shortage of irrigation water in nations downstream in the summer while its discharge of water for power generation in winter caused floods in the river's lower reaches. Because the lower reaches of the Syr Darya froze in winter, its capacity

Pict. 2: Leaching from irrigated Farm lands leads to the accumulation of salt on neighboring agricultural sites.

declined, increasing the damage. The Chardara Dam in Kazakhstan, with a reservoir capacity of 5.7 billion m^3, and an active storage capacity of 4.4 billion m^3, cannot control floods alone and Kazakhstan must let an excess of 3.0 billion m^3 in water overflow each winter into the Arnasai Depression in Uzbekistan, next to the dam, and eventually discharge it into saline Lake Aidar. Lake Aidar has grown into the "second" Aral. Water flowing into the depression does not reach the Small Aral, it mixes with salt water and loses its value as a water resource.

"Plantation Biomass Society" in South East Asia

This essay has primarily presented results from research done in Central Asia but, its lessons have value when we consider the fast-paced changes that are occurring in Southeast Asia. Fast-economic growth and the need to capture, extract, and allocate energy resources from biomass, are radically transforming the region and restructuring some nations where damming and intense commodity cropping is taking place. Southeast Asian nations possess a vast resource of biomass which has historically supported many civilizations and cultures in the region. The tropics in Southeast Asia have one of the world's highest potentialities to reproduce biomass due to far greater solar radiation and active heat and water cycles than other regions. The region has also been, and will continue to become, the most fertile ground for bio-resource commodification in human history. With the changing status of biomass as forest and agricultural products, bio-materials, and financial instruments (related to carbon sinks, REDD initiatives and so forth) the tropical zone will continue to undergone a fast-paced metamorphosis through the development of an intensive and technological agro-industrial production system, including large-scale plantations of oil palm, *Acacia mangium*, teak, coffee, tea, sugarcane, and cassava, to name but a few. Large areas of primary and secondary forest are being replaced by them. Uzbekistan shows us the folly of large-scale environmental manipulation, allocation, and extraction of resources and how, over the short-term, human intervention can create very real changes to local climates. We require further comparative studies from other parts of the world so that we can further our understandings and responses to future changes in the region. Comparing to what is taking place in other regions can help us formulate responses to the rapid changes that are taking place in Southeast Asia.

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Notes

[1] Albedo is the fraction of incident radiation reflected by a surface or body, commonly expressed as percentage.

[2] Surface roughness, often shortened to roughness, is a measure of the texture of a surface. It is quantified by the vertical deviations of a real surface from its ideal form.

[3] The concept of multiple steady states is a key theory for understanding the dynamic nature system. Nature's systems possess the possibility to have different steady states.

[4] Vegetation is a very general term for plant life; it refers to the ground cover provided by plants.

[5] This cycle is the continuous physical process of evaporation, precipitation, infiltration, runoff and subsurface flow of water.

[6] See Razuvaev V. N., Apasova E. B., and Martuganov R. A. 1998.

[7] See Toderich, K., Black, C. C., Juylova, E., Kozan, O. Mukimov, T. and Matsuo, N. 2007.

[8] See Spektorman T. Y. 2002.