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Catch Me if You Can: Invasive Water Hyacinths Emerge as Unlikely Renewable Energy Source

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Water hyacinths block transport vessel passage in the Pearl River.

Last month, the section of Pearl River running through the city of Guangzhou in China was rapidly invaded by an explosion of water hyacinths. After two days of intense skimming (455 tons of water hyacinths removed on the 17th and 495 tons on the 18th), the river was still not fully cleared. Last month's rainfall washed the plants downriver causing them to accumulate in the slow-flowing estuary, a common occurrence in flood season. From April to June of this year, water hyacinths accounted for 80 percent of the 15,000 tons of floating rubbish collected by Guangzhou city.

Introduced to China in the 1960s, the water hyacinth is now widely distributed in nineteen provinces across the country. Warming temperatures due to climate change have created favorable growing conditions for water hyacinths across most of China – plant mass can double in two weeks in water temperatures between 27 and 35 degrees Celsius. Floods of water hyacinths occur regularly in many important bodies of water, including Dianchi Lake and Yangtze River.

As an invasive species that multiplies rapidly, heavy infestations of water hyacinths have to be quickly removed from impacted water systems to prevent economic and environmental damage. While water hyacinths do remove nutrient pollutants (N, P, K, Mg, Cu, Zn, and Mn) from waters, outbreaks cover water surfaces and consume most of the dissolved oxygen leaving little for fish and other aquatic species, which die off as a result. Unless removed, water hyacinths release nutrient pollutants back into the water when they die. Massive outbreaks cause further economic harm by blocking water transportation.

Despite these serious drawbacks, water hyacinth invasions can be harnessed for environmental benefit and renewable energy production. Water hyacinths have high cellulose content, making them a potential renewable energy source. Currently however, technical and cost barriers have forestalled widespread development of this energy option.

Dehydration is normally a necessary step in transforming biomass into energy fuel. Water hyacinths are composed of 90 percent water, making this step particularly inefficient. Alternatively, ethanol can be produced through hydrolysis fermentation, currently still an expensive process. Water hyacinths can also be used to produce solid fuel, though with a low combustion value of 8.3 gigajoules (GJ) per cubic meter (m^3) – less than wood – this approach remains inefficient.

Water hyacinths can also be used to produce biogas, an energy source that has already embraced in much of rural China. Of the two main approaches for biogas production, methane fermentation is currently the most feasible. One hectare of water hyacinths can produce enough biogas each day to generate between 90 and 180 cubic meters of methane, equivalent to approximately 3.44 to 6.88 GJ of energy production. The half-ton of residue remaining from this amount of biomass combustion can be used as fertilizer, offsetting costs for farmers harnessing this energy source. The other method of biogas production, hydrogen fermentation, is currently prohibitively expensive due to water hyacinth's low-sugar and cellulose-rich nature.

Pre-treated water hyacinths can also be combined with animal waste to create an efficient source of biogas, releasing 249.1 m^3 of methane per kilogram (kg) of water hyacinth, enough to produce 9.54 GJ of energy. There is no consensus on what the most efficient pretreatment should be, with disagreement over ideal biogas digester temperatures and mixing ratios. To date, research has shown that biogas production is more efficient with dried water hyacinths than with fresh ones. Scientists also agree that adding animal waste to the biogas digester boosts methane production volume and efficiency.

By-products of energy production from water hyacinths provide additional utility, and can partially offset the cost of using water hyacinths as an energy fuel for agricultural uses. Water hyacinths are already used as low-cost animal feed. For example, sun-dried and chopped water hyacinths have been used to replace alfalfa for breeding rabbits, and cooked hyacinth leaves and stems are an effective supplement in commercial fattening of Yorkshire pigs. Farmers can also add excess animal feed to biogas digesters along with animal waste. Since digesters are already popular in China's rural areas, using water hyacinths would benefit farmers by decreasing energy fuel costs.

As one of the world's most invasive perennial aquatic weeds, water hyacinths can nevertheless serve useful purposes in addition to energy production and animal feed. These include removal of nutrient pollutants from affected water systems, fertilizer production, and even high-quality substitution for wood in furniture production.

While controlling water hyacinth populations has proven to be beyond the capabilities of local governments, using these plants for energy production and other uses provides an alternative approach to dealing with the invasive species. Comprehensive management plans that make use of water hyacinths, as described above, should be developed to realize their ecological and economic benefits.

agriculture, biofuels, biogas, biomass, China, water

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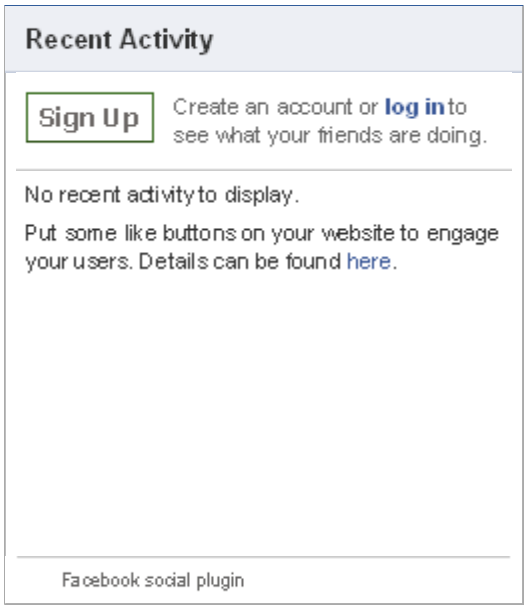

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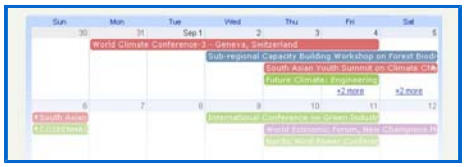

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