Three Reasons Why Cities Need to Get in the Sequestration Game and Five Ways to Do it

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Last year brought more sobering news about climate change from the world's scientific community. Both the IPCC report on the Paris Agreement and the US National Climate Assessment used uncharacteristically direct and urgent warnings that climate change is proceeding faster than expected and the time remaining to avert large-scale catastrophic impacts may now be less than two decades. Within these reports are three critical points relevant to anyone engaged in efforts to stabilize climate.

1. Emissions reduction will not be enough to stabilize climate

An important focus of these two reports was the emphasis on the insufficiency of emissions reduction strategies alone to stabilize climate. In even optimistic future emissions scenarios, the accumulated carbon budget to stay within manageable climate change will be exceeded. These reports and many others all point to the inescapable fact that large-scale carbon recapture/sequestration must now be scaled up rapidly if we are to maintain a livable planet.

2. Near-term carbon capture is critical to buy time for longer-timeframe infrastructure change

As those actively engaged in efforts to change energy systems are well-aware, the essential process of large scale infrastructure change—from residential buildings to energy delivery and production infrastructure—is an immensely expensive, logistically complicated, and politically difficult transition to enact rapidly. With a shrinking timeframe within which to effect this change, we need to find ways to reduce the warming factors as fast as possible in the near-term. Many biological systems—both terrestrial and aquatic—have both rapid and large-scale capacity to recapture carbon in the near-term while working toward longer timeframe structural transitions.

3. Carbon-rich ecological systems are more resilient to climate change

As we now also face the reality that climate change is already underway and having increasing impacts on cities and surrounding landscapes, a growing body of information demonstrates that healthy carbon-rich soils, landscapes, and aquatic systems are more capable of buffering climate extremes. Cities with carbon-rich water and nutrient-holding ecosystems will be more resilient to heat island impacts, flooding, wildfire behavior, air and water quality improvement and other environmental extremes that will occur with increasing frequency and intensity in the coming decades.

Taking Organics Out of the Waste Stream

Recycling organic waste, instead of disposing of it in landfills, ends the emission of CO_2 and methane due to decomposing organics in landfills. As much as 5% of global GHG emissions emanate from the solid waste sector, most of it from rotting organics. The emissions from organics are extremely problematic because methane is about 25 times more potent than CO_2 in trapping heat in the atmosphere.

Recycling organic waste can also replace fossil fuel-based products with renewable ones. Composting uses microorganisms to break down organics into the essential component of soil (called humus), which can replace fossil-fuel based fertilizers. Cities also use anaerobic digestion facilities to turn organic waste and sewage into biogas, providing clean fuel for buses and other heavy vehicles instead of fossil fuels. When cities sell their compost and biogas for use, they generate revenue that covers some of the cost of the organics recycling system—the beginning of a "circular economy" model.

Composting reduces GHG emissions in yet another way. Compost added to the soil can draw CO_2 out of the atmosphere and enhance the soil's capacity to sequester/hold the carbon—especially in no-till situations, such as in orchards, vineyards, and grazing lands, where the soil is not disturbed in ways that would release the CO_2.

Turning organic waste into a decarbonizing asset involves the mandatory collection and sorting of food waste, yard clippings, and other biodegradable waste from residences, businesses, and institutions (hospitals, schools, etc.) so that it is kept out of landfills where it would generate GHG emissions. The organics are separated from the rest of the waste stream and recycled into carbon-capturing compost for sale to nearby farms and landscape use or bio-gas for vehicles and industry.

High Impact City Sequestration Opportunities

While few cities currently have active efforts to assess, develop and implement sequestration strategies, there are at least five major entry points accessible to almost every city to begin exploring this opportunity.

1. Direct sequestration on city lands

Most cities have land holdings. In addition to parks, some have larger open space holdings. Boulder's urban parks encompass over 1,500 acres. The city's agricultural holdings encompass over 15,000 acres. Chicago, as an example of a larger city, has 500+ parks covering over 7,500 acres. A variety of soil management techniques including compost, biochar, biological inoculums, and mineral treatments show significant promise. A combination of these treatments could enable the soil to capture significant amounts of carbon: 1-5 tons of carbon per year by some projections. When converted to its CO2 equivalent, this pure carbon represents over 3½ times that amount of CO2. By some projections, soil treatments on 2,000 of Boulder's open space lands could result in capturing over 35,000 tons of CO2. In contrast, the city's long-standing residential and commercial energy efficiency programs reduce carbon emissions by around 2,000 tons annually.

2. Indirect sequestration: urban green waste to land-applied compost

San Francisco has done an extensive analysis of its urban green waste and the potential for directing this to land-application composting. The city currently generates approximately 187,500 tons of urban green and food waste per year which when processed yields 70,000 tons of compost.

While San Francisco captures over 50% of its organic waste stream this is an outlier of success in most cities. For most cities in the US 50-60% of waste is organic materials, the majority of which ends up in landfills resulting in the powerful climate forcer, methane. The pioneering work of the California Marin Carbon Project demonstrated significant carbon sequestration potential for compost applications in managed agricultural sites like orchards and vineyards, and in open range applications. Through strategic use of these urban carbon and nutrient flows in land-based sequestration, cities both reduce future landfill methane emissions from landfills and facilitate land-based carbon recapture and soil/land productivity and resilience improvements.

Following the findings of the Marin Carbon Project, if San Francisco used its 70,000 tons of compost to treat degraded range lands with 1/4 inch of compost, that would allow them to cover 1,200 acres every year. Starting in 2020 and going to 2030, using conservative estimates, this would result in just over 400,000 metric tons, or 10% of San Francisco's 2016 carbon footprint, being sequestered. And for every ton of CO_2e sequestered, upwards of 50-70 tons CO_2e are avoided upstream.

3. Ocean/aquatic sequestration

Aquatic systems have enormous potential to capture carbon because of rapid carbon cycling, particularly in ocean and estuarian ecosystems. Groups like the Climate Foundation are pioneering "marine permaculture" that regenerates multi-layered ocean ecosystems that both fix carbon and rapidly restore improved ecosystem conditions. Yokohama, Japan, has developed an exciting initiative called **"Blue Carbon"** (funded in part by the CNCA Innovation Fund) that includes support for developing a local coastal seaweed production paired with the development of an offset market to subsidize the initial development of the sequestration system. This project demonstrates that while cities may not control large areas of aquatic environments, they can serve as early hosts for innovation around aquatic sequestration/regeneration. This emulates the pivotal role cities have played in many cases around energy systems change.

4. Biomass Energy + Carbon Capture and Sequestration (BECCS)

A major focus in the climate stabilization scenarios put forward by IPCC and others is the large-scale development of biomass energy systems that are paired with carbon capture and storage. These schemes depend on many as-yet unworkable elements including cost-effective capture and stable and accessible storage. A far simpler, more scalable and much less expensive alternative is the use of biochar systems that capture and utilize the released heat as a renewable thermal energy and generate long-term stable carbon (biochar). The base "fuel" for these systems is low grade biomass: urban wood waste, fire hazard reduction thinnings, agricultural waste and other low grade biomass. The resulting biochar can be used in land applications to both capture more carbon and improve water retention. Boulder is hosting a pilot scale bioenergy-biochar system in the summer of 2019 that will be used to assess the feasibility for larger scale distributed deployment of these technologies.

5. Offsets to local sequestration projects

Given the bundle of values that can be derived from the development of both terrestrial and aquatic carbon recapture projects in and around cities, we believe this represents a powerful opportunity to explore local voluntary carbon markets that support local ecosystem regeneration/carbon sequestration projects. Yokohama has already initiated aspects of a local offset program, initially targeting large sporting events. Boulder is exploring expansion of its current marijuana energy impact offset fund as a potential foundation for a local carbon offset fund. Boulder and San Francisco are also exploring emerging initiatives to link carbon capture projects with block-chain based digital currencies using tonnes of carbon as the denomination that is valued.

Next Steps

The active engagement of cities in emission reduction initiatives has been a major factor increasing both issue profile and innovation around energy system transitions. With the emerging realization that emissions reduction alone will not stabilize climate unless it is paired with rapid development of carbon recapture efforts, cities once again have a potential role in both raising awareness and fostering innovation in this sector. A unique aspect of this area of action is the significant additional local benefits that carbon sequestration initiatives could bring to cities.

The next steps for cities interested in further exploration of this sector would be to conduct initial assessments of assets and knowledge in a number of key areas including:

- Assessing sequestration potentials
  - Land within city control or influence that could be receive sequestration enhancing treatments
  - Ocean-aquatic zones within city control or influence
- Assessing biomass waste opportunities: Inventory existing green wastes and available infrastructure for composting or other biomass processing
- Assessing potential BECCS: Conduct renewable thermal opportunity assessment, particularly in larger scale commercial industrial settings
- Considering local offsets opportunities: Explore the creation of a local carbon offset market directed to projects in terrestrial or aquatic sites in and around cities that generate multiple benefits

For more information or to be a part of the CNCA Sequestration Working Group, please contact **Brett KenCairn** or **Trude Rauken.**