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Philosophical Considerations of Sustainability

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ABSTRACT

An attempt at a synthesis of the varied definitions of sustainability is given. This involves the full utilization of the waste stream: mining, agricultural, industrial, municipal & sewage sludge. Various waste recycling & reuse "loops" are compiled to show how waste can be used in both agricultural & industrial societies that prioritize sustainability. The choice of waste use between recycling, composting, gasification, pig food, biochar, no till of crop residues & fermentation are not easy decisions. Some uses of waste are considered here but there is no one overriding method that can be applied universally.

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Some Definitions of Sustainability

- The long-term viability of a community, set of social institutions, or societal practice [1]. The ability to support or maintain a process over time [2].
- Avoidance of the depletion of natural resources in order to maintain an ecological balance:
- Sustainability is a long-term goal for our society to meet the needs of economic growth at its current speed with the least amount of impact on the environment [3].
- Sustainability is a social goal for people to co-exist on Earth over a long time [4].

Sustainability Commonly Assumed to have 3 Domains

These are environmental, social, and economical. The intersection of these three domains corresponds to a balanced, sustainable situation.

However if one considers that using waste for both recycling & fuel purposes will fulfill the principal sustainability rule, the circular economy, then sociology becomes a secondary, though important, consideration. It is this restricted perspective of "use the waste first" that is advocated here. It is believed that if this one objective is achieved then all 3 domains should automatically fall into harmonious balance.

The different categories of waste are considered here from the point of view of their potential uses as well as their origin.

Figure 1 (all waste)

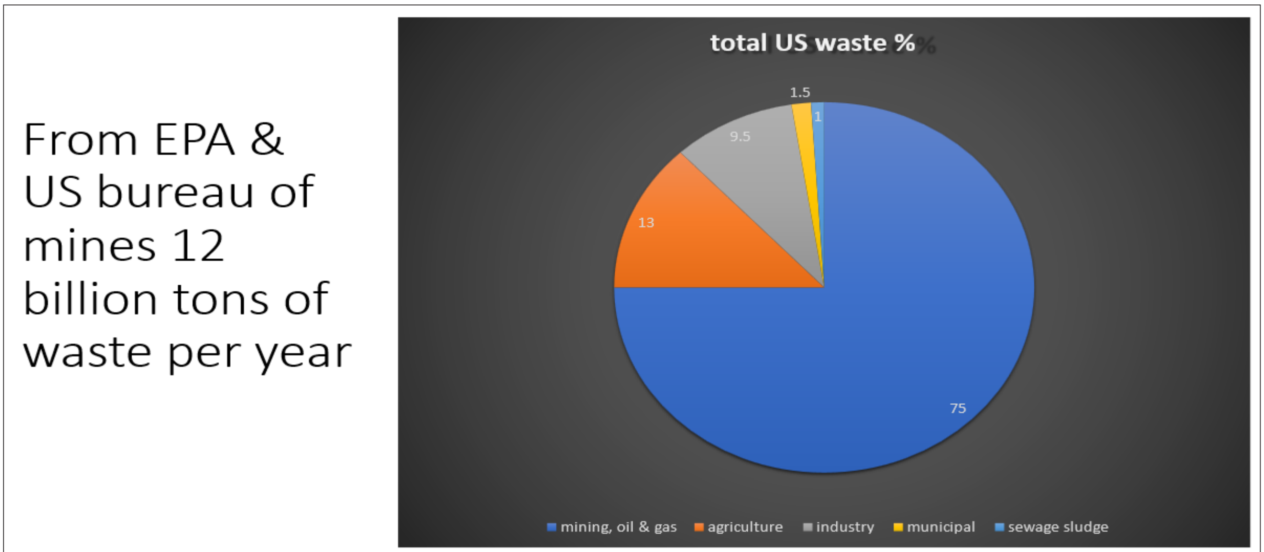

Figure 1: Shows the Major Classes of Waste & Their Relative Abundance in the USA Taken from the EPA. 2004

Figure 1 shows that the major class of waste is rock debris from mining, oil & gas (75%). Long considered useless, it has recently been employed in the manufacture of artificial sand where it is used in construction, particularly in concrete manufacture [5]. In terms of abundance, agricultural waste is next (17%). It is fully combustible & consists largely of cellulose, hemicellulose & lignins [6]. Carbonized or buried it is potentially a most valuable carbon sequestrant. Industrial waste is the third most abundant class [7]. Types of industrial waste include dirt and gravel, masonry and concrete, scrap metal, oil, solvents, chemicals & scrap lumber. Much of it can be recycled, but most of it is landfilled. Municipal waste is only 1.5% of total wastes, but is the most conspicuous, as it is city derived. It is considered in Figure 2. Sewage sludge is only 1% of total wastes but is of comparable volume to municipal waste. Use of sludge as land applicant or fuel may be questioned on account of potential pollution [8].

Figure 2: Municipal Waste

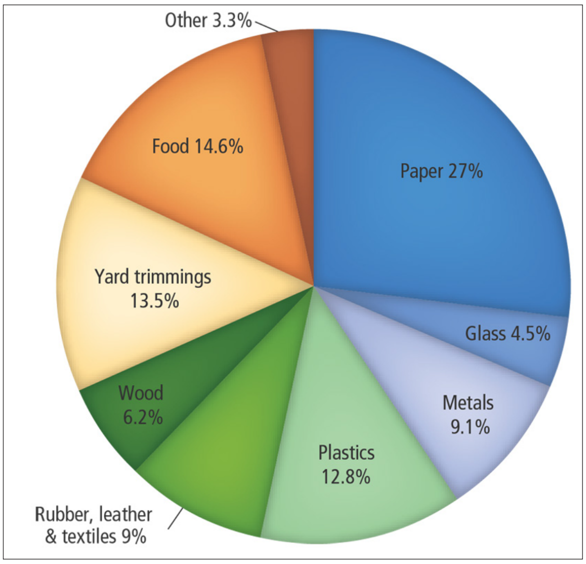

Figure 2: Shows a Breakdown of Municipal Waste National Overview: Facts and Figures on Materials, Wastes and Recycling | US EPA [9].

The composition of municipal solid waste (MSW) is shown in Figure 2 taken from [10]. MSW is predominantly biomass (>60%) that generates abundant methane in landfills. Paper is extensively recycled but food waste has no use, except in Cairo, Egypt where it was fed to pigs [11]. However frying grease, oils and fats do have a ready market as they can be refined into a carbon - neutral petroleum substitute [12]. Municipal waste (MSW) may be burned, as most of it is carbon neutral. In Dubai 45% of MSW is scheduled for power generation. Dubai has installed a large municipal waste to energy plant that accepts about half of the cities waste. Because the waste is incinerated at high temperatures, harmful dioxin emissions are eliminated. The CO2 evolved is carbon neutral as much domestic waste is paper, food & yard waste [13]. In Japan unsorted municipal waste is often converted to syngas then to ethanol [14]. Recycled plastics are gasified to hydrogen & CO2. The syngas or hydrogen is then used for petrochemicals in the beginnings of a waste – based, closed loop, petrochemical industry [15]. Still most recycled plastics are incinerated in Japan. Another use of waste is by composting. Municipal waste is more than half, by weight, paper, and food & yard waste. This will compost at high temperatures to give excellent, carbon - negative fertilizer.

Other attempts to “close the loops” are being taken by the Royal Mint in Britain that is accepting electronic waste to recover gold, silver, copper, palladium etc, [16].

In the US damaged cars, wrecks etc. are comprehensively cannibalized for spare parts before being used as steel scrap [17].

The list of uses for waste are becoming extensive. Each waste stream “loop” marks a part of what could eventually become a sustainable “Smart City” in a circular economy where the state survives on its wastes alone (as on a lunar base). It would include recycling, conversion to syngas & petrochemicals, as well as combustion.

Alternatively, yard waste (leaves, clippings) is being used by some as the basis of start – up paper industry instead of using trees. The paper would be carbon negative. The entire agricultural waste output could be used for paper manufacturing! [18].

Other uses for municipal waste includes the generation of resin pellets for use in construction material (UBQ) [19].

The other philosophical question involves integration. How closely should the various recycling loops be integrated?

One approach is the existing one: the different recycling loops are independent of each other.
Another approach is the ecological one. The different recycling loops could mimic those of an ecosystem where all waste is used by various decomposers whose own waste products feed primary producers (vegetation) [20].

A third perspective is that of closest integration, the “superorganism”; here the recycling loops mimic the metabolic pathways & circulation system of a sentient organism. The AI based city then becomes a municipal cell inside the multicellular nation state. The “smart city” could respond to environmental changes. Increased City Street temperatures, during hot summers may, perhaps be cooled by directing clarified, cleansed, sterile sewage effluent (with phosphate removal) onto tree - lined city streets & gardens. Similarly, during cold snaps, city waste could be directed into waste to energy facilities to increase the supply of electricity. The different city industries & commercial enterprises, along with their respective “waste conversion loops”, become the organelles of a single cell – i.e. The entire municipality.

Essentially the Discipline of Economics Becomes Part of Biological Studies

The different possible uses of waste, including fuel, carbon sequestrant or recycling “loops”, permit one to envisage a holistic scenario whereby sorted waste is shipped direct to an industry that could use it but maybe has demurred in the past due to cheaper raw materials being available. Thus mixed plastic waste could be taken to an oil refinery for depolymerization and monomer separation (or syngas generation) instead of crude oil. Food & paper waste similarly for syngas generation. The refinery would receive carbon credits that could be used to offset its own emissions. Similarly householders that sort their waste could receive carbon credits that could be used to offset municipal taxes.

Conclusion

It may be possible to formulate an algorithm or model that takes the processed waste stream, as well as companies to process it, to propose models of sustainable cities as well as rural hinterland. This model may have similarities to a living cell with its many

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biosynthetic pathways. The results would be useful in building a sustainable lunar base or a refugee camp.

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