RESTORING FIRE RAVAGED LAND IN CALIFORNIA WITH BIOSOLIDS

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Authors' Note

This paper introduces trials underway in Southern California, USA, to utilise biosolids compost on fire ravaged land there, based on the successful research which was conducted in Colorado in 1996, as noted in this paper. This paper is intended to offer a possible option for successful mitigation of adverse affects from the Victorian fires, much as we hope to do for California.

Introduction

We are proposing an extensive trial in southern California, USA, to utilise biosolids compost on fire ravaged land, based on successful experience in central Colorado, USA some years previously (Meyer *et al*., 2001; Meyer *et al*., 2004) and recent field work, where surface application of biosolids compost was found to improve vegetative productivity when applied to land that had been severely burned. Recent results confirmed that, while the average vegetative yield on control plots was 94.2 kilograms per hectare (dry weight), the vegetative yield on test plots amended with biosolids ranged from 146.7 to 743.8 kilograms per hectare (McFarland *et al*., 2007a; McFarland *et al*., 2007b). Furthermore, vegetation grown in biosolids amended soils did not succumb to drought stress and remained "green" well into the summer and fall growing seasons. These data indicate that biosolids land application not only increases the vegetative density but increases the vegetative moisture content.

We outline below our research program to systematically establish best management practices (BMPs) governing the use of biosolids compost and selective seeding of native species to restore the ecological functions of fire ravaged landscapes. Similar efforts might be useful in Australia as a consequence of the recent extensive fire activity and devastation there so despite the difference in the endemic vegetative species, we suggest that partnering for shared understanding and communication would be beneficial.

The Challenge

Because of the recent increases in the frequency and severity of wildfires, vast swathes of California landscape now suffer extensive water quality impairment, increased risk of flooding and landslides, sparse native vegetation and invasive plant proliferation. Following the huge conflagration in 2007,a series of wildfires in November 2008, known as the Freeway Complex Fire ravaged over 30,000 acres of land in Orange, Riverside, and San Bernardino Counties in southern California and caused severe damage to property as well as state parks. Governor Schwarzenegger declared this impacted area an emergency and on November 28th, 2008, the Santa Ana Regional Water Quality Control Board passed an emergency resolution to facilitate the use of compost to minimise water quality impacts, provide erosion control and improve slope stability on these landscapes.

The Landscape

Southern California landscapes serve a number of vital ecological functions including providing: 1) forage for wildlife and livestock production, 2) habitat for native flora and fauna, 3) watersheds for meeting drinking water and agricultural needs and 4) sequestration for atmospheric CO_2. However, because of the increased frequency and severity of wildfires, many California landscapes are severely degraded. Wildfire-induced defoliation of native vegetation together with the destruction of soil structure has led to: 1) increased soil erosion, 2) impairment of water quality, 3) proliferation of invasive plants, 4) loss of vegetative biodiversity and 5) decreased recurrence interval for wildfires.

Chaparral, which is the dominant habitat found in the hills and mountains of southern California, is classified as a shrub-land consisting of densely growing and drought resistant vegetation. When fire recurrence intervals drop below 10 to 15 years, many chaparral plant species are eliminated and the landscape vegetation is replaced by invasive plant vegetation. The impacts of invasive species on southern California landscapes are evidenced by increased fire intensity as shown in Figure 1.

Today, almost all grasses in the California chaparral landscape are invasive and include such species as cheatgrass *(Bromus tectorum),* wild oats *(Avena* spp.), bromes *(Bromus* spp.) and ryegrasses *(Lolium* spp.). The presence of invasive vegetation creates an abnormal situation that increases both the frequency and the severity of wildfires. Invasive weeds are opportunistic plants that not only out-compete native vegetation for scarce resources (e.g. nutrients, water) but seed and dry-out early in the spring providing an abundant fuel source for summer/fall wildfires. Moreover, even after chaparral wildfires have been extinguished, invasive plant species typically re-establish themselves rapidly further suppressing the recovery of native vegetation.

Figure 1. Fire Ravaged Southern California Landscapes – Orange County, California.

Biosolids Compost Application: Previous Experience

After a severe or prolonged wildfire, the loss of plant nutrients and the destabilisation of the soil structure can inhibit vegetative growth resulting in increased soil erosion and subsequent deterioration of surface water quality.

Historical monitoring of fire impacted areas has demonstrated that the greater the extent of soil heating, the higher the rate of nutrient and soil organic matter loss resulting in a lower recovery rate of vegetation.

Soil heating tends to facilitate the volatilisation of nutrients (particularly ammonia through the accelerated mineralisation of organic nitrogen). High temperature wildfires are effective in not only accelerating nutrient removal but can adversely impact the water holding capacity, soil porosity and moisture infiltration rate of terrestrial ecosystems. During an intense wildfire event, vaporised soil organic matter will move deeper into the soil profile and condense in the cooler underlying soil layers. At the depth at which organic matter condensation occurs, a water repellent or hydrophobic layer will be established that further reduces moisture infiltration. Under these circumstances, even a mild rainstorm event can potentially cause significant moisture runoff, soil erosion and surface water quality impairment.

Land reclamation field work conducted on the Buffalo Creek, Colorado, wildfire site in 1996 demonstrated that biosolids application on slopes ranging from 15 to 50% was capable of: 1) protecting run-off water quality, 2) decreasing soil erosion and 3) increasing biodiversity (Figure 2) (Meyer *et al*., 2001; Meyer *et al*., 2004). In 1997 biosolids applied at one time rates of 0 (control) up to 80 metric tons per hectare were tilled (disked) on the wildfire burn site, which was then followed by reseeding with a mixture of native grasses. Plant biomass was found to increase by as much as 222 grams per square metre (dry mass basis) after the first year, 202 grams per square metre in the second year, 100 grams per square metre in year three and 76 grams per square metre in year four (Meyer *et al*., 2004). The decrease may have been due to nitrogen utilisation, but was more likely due to a deepening drought. Moreover, the seeded native grasses were found to account for more than 90% of the total vegetation produced while invasive species decreased with application of compost.

Californian Study Methodology

To evaluate the effectiveness of land applying biosolids compost to restore the ecological functions of fire ravaged landscapes, field plots located on recently burned areas in Orange, Riverside or San Bernardino Counties in California will be established. Class A biosolids compost will be applied to each site at 0, 1 and 3 times the estimated annual agronomic rate, based on evaluation of the background soil nutrient conditions, biosolids nitrogen content and the nitrogen requirement of the native vegetation.

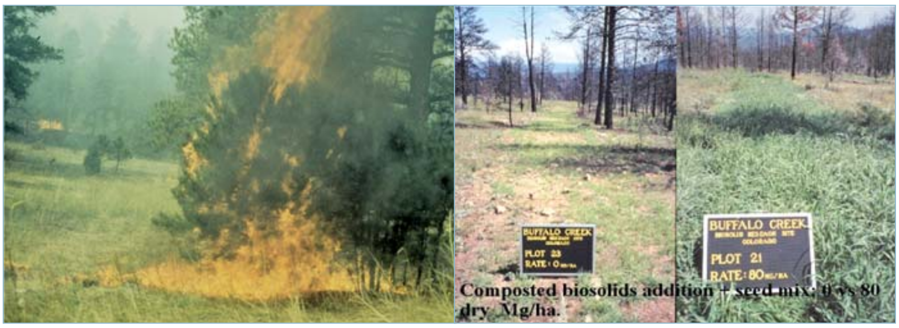

Figure 2. Photographs of the 1996 Buffalo Creek, Colorado Wildfire. (a) Ground View of Wildfire Impacting Understory and Tree Canopy: (b) Effect of Biosolids Compost Use (control on left and highest application rate on right) in Restoring Fire Impacted Land in Buffalo Creek, Colorado.

Biosolids compost will be surface applied without incorporation (i.e., tilling) to represent a worst case scenario. Following application, half of the control and treatment plots will receive reseeding of native grass species. To mimic real landscape restoration activities, none of the field test plots will be irrigated.

Our subsequent monitoring methodology, for both physico-chemical and biological parameters, has been thoroughly developed, and is available in detail for interested readers (US EPA (2009). It extends to sampling soils to one metre in depth for regulated biosolids pollutants and during storm events, grab samples of storm water run-off will be collected for analysis. Preliminary estimates of the net accumulation of soil carbon will be utilised to gauge the feasibility of utilising biosolids compost to enhance mitigation of global climate change through reclamation of fire ravaged landscapes.

Conclusion

To mitigate the potential human health and environmental risks associated with fire ravaged landscapes as well as to improve their ecological function, the California Association of Sanitation Agencies in conjunction with the US Environmental Protection Agency, Santa Ana Regional Water Quality Control Board and a number of partner Southern California wastewater agencies and compost producers plan to investigate the effectiveness of biosolids compost to restore the ecological functions of selected field test sites located within fire impacted zone. Results from this research effort will be used to establish BMPs for the application of biosolids products in reclaiming fire ravaged land. If successful, the field demonstration results will support a significant diversification in the potential uses, markets and demand for biosolids with the potential to offset increasing wastewater treatment costs.

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