Gains and Threats from Smouldering Combustion to Biochar Production and Storage

Guillermo Rein G.Rein@ed.ac.uk
BRE Centre *for* Fire Safety Engineering, The University *of* Edinburgh

BRE Centre for Fire Safety Engineering

1. INTRODUCTION

On the one hand, smouldering combustion can provide energy-efficient conversion of biomass into biochar. On the other hand, smouldering fires are a mayor menace to biochar storage fields and can reduce them to ashes.

Like biochar, most organic solid materials can sustain a smouldering combustion, including forest biomass, duff, peat, wood, coal, cotton, and most charring polymers.

Figure 1 – Flaming vs. smouldering combustion of biomass

2. SMOULDERING

Smouldering is the flameless form of combustion of a solid. The oxidation reaction occurs on the surface of the solid (Fig. 1) rather than on the gas phase as in flaming. The characteristic temperature (500-700°C) , spread rate (1-50mm/h) and heat release rate (~8 kJ/g) are significantly lower than in flaming combustion.

3. GAINS *to* BIOCHAR

Biochar is produced by the pyrolysis conversion of biomass (Fig. 2). Pyrolysis is an endothermic process that requires an energy external input. This external supply increases the energetic cost of biochar production. One process that promotes biochar conversion with the advantage of minimal or zero energy costs is a smouldering process where the energy supply is released from the slow oxidation of a part of the biomass itself.

Small, easy to operate and maintain reactors can be designed to be run by local small communities.

Natural smouldering consumes most of the fuel (Fig. 2), specially the char. Thus, controlling the two governing variables, oxygen supply and heat losses, is required to reach optimum biochar yields at low energy costs.

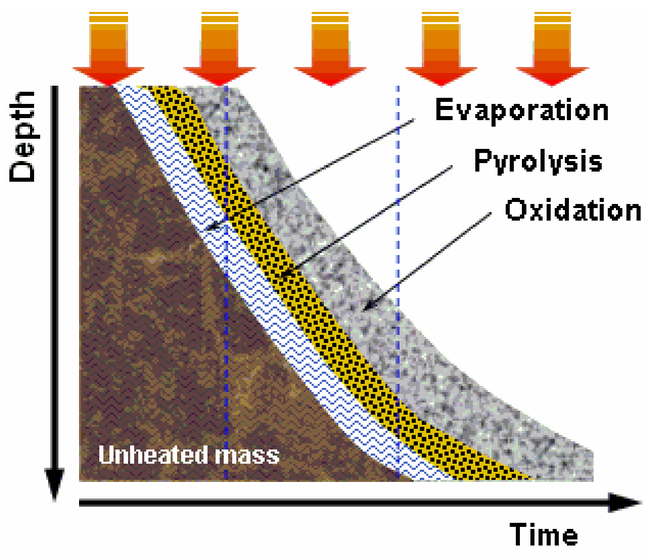

Figure 2 – Depth vs. time sketch of a downward smouldering front showing the evolution of the front structure [2].

4. THREATS *to* BIOCHAR

When a layer of organic soil ignites on the surface, it smoulder steadily and slowly without flame (Fig. 3) and propagates slowly into the soil, reaching deeper locations (Fig. 3). In case of occurring in a biochar field, a smouldering fire could propagate through the surface and subsurface layers destroying the biochar and releasing its carbon as gas emissions [2]. This is about the only hazard that can led to an accidental release of the stored carbon to the atmosphere. Smouldering fires occur regularly at a global scale and can linger for very long periods of time, weeks, up to years and centuries depending on the amount of fuel available. Once ignited (Fig. 4), they are particularly difficult to extinguish despite extensive rains or fire-fighting attempts.

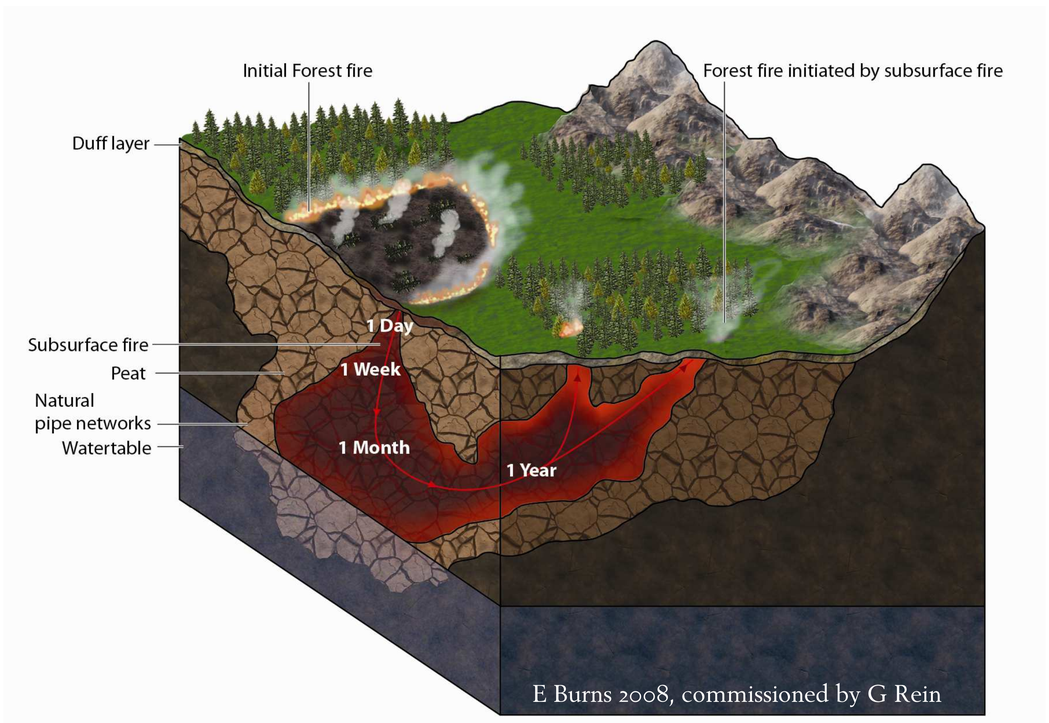

Figure 3 – Illustration of a subsurface fire initiated at the surface that propagates into the ground and emerges months later

Figure 4 – Smouldering front burning on peat and leaving behind char formation [1]

[1] Rein et al, "The Severity of Smouldering Peat Fires and Damage to the Forest Soil", *Catena 74 (3), pp. 304-309,* 2008
[2] Rein et al, "Carbon Emissions from Smouldering Peat in Shallow and Strong Fronts", *Proceedings of the Combustion Institute* 32 (in press), 2009.

Presented as poster at the 2008 Conference of the International Biochar Initiative, Newcastle, 9th Sept 2008

International Biochar Initiative