



Does introduced fauna influence soil erosion? A field and modelling assessment



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HIGHLIGHTS

- The impact of feral pigs on soil erosion was examined.
- Field data (3 years) showed that pigs disturb large areas and exhume large volumes of soil.
- However, the long-term soil erosion effects were minimal.
- Using numerical modelling, this finding was found not to apply to other sites such as mine sites.

ARTICLE INFO

Article history:

Received 22 October 2014

Received in revised form 25 February 2015

Accepted 25 February 2015

Available online 7 March 2015

Editor: F. Riget

Keywords:

Soil erosion

Mine rehabilitation

Feral pigs

SIBERIA

Animal disturbance

ABSTRACT

Pigs (*Sus scrofa*) are recognised as having significant ecological impacts in many areas of the world including northern Australia. The full consequences of the introduction of pigs are difficult to quantify as the impacts may only be detected over the long-term and there is a lack of quantitative information on the impacts of feral pigs globally. In this study the effect of feral pigs is quantified in an undisturbed catchment in the monsoonal tropics of northern Australia. Over a three-year period, field data showed that the areal extent of pig disturbance ranged from 0.3–3.3% of the survey area. The mass of material exhumed through these activities ranged from 4.3 t ha⁻¹ yr⁻¹ to 36.0 t ha⁻¹ yr⁻¹. The findings demonstrate that large introduced species such as feral pigs are disturbing large areas as well as exhuming considerable volumes of soil. A numerical landscape evolution and soil erosion model was used to assess the effect of this disturbance on catchment scale erosion rates. The modelling demonstrated that simulated pig disturbance in previously undisturbed areas produced lower erosion rates compared to those areas which had not been impacted by pigs. This is attributed to the pig disturbance increasing surface roughness and trapping sediment. This suggests that in this specific environment, disturbance by pigs does not enhance erosion. However, this conclusion is prefaced by two important caveats. First, the long term impact of soil disturbance is still very uncertain. Secondly, modelling results show a clear differentiation between those from an undisturbed environment and those from a post-mining landscape, in which pig disturbance may enhance erosion.

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1. Introduction

The concept of biogeomorphology has been well-recognised (Viles, 1988). Faunal biological agents have long been considered to be important in the evolution of landforms (Humphreys, 1981; Goudie, 1988; Mitchell, 1988; Gabet, 2000; Gabet et al., 2003; Butler, 1995; Wilkinson et al., 2009; Fleming et al., 2014). However, in many areas, new species have been introduced which have been observed to produce considerable disturbance and surface change (Tisdell, 1982; Spencer et al., 2005).

Pigs (*Sus scrofa*) have been recognised as having significant ecological impacts in many areas of the world including northern Australia (Imeson, 1976, 1977; Tisdell, 1982; Bowman and McDonough, 1991; Caley, 1993; Hone, 1995; Spencer et al., 2005; Mitchell et al., 2007a,b; Taylor et al., 2011) (Fig. 1). Pigs are omnivores and as part of their diet may exhume the roots of suitable plant species. Given that pigs are prolific breeders and large numbers can develop in suitable seasons these animals can disturb large amounts of soil in search of edible roots (Figs. 2, 3 and 4). Pigs are a relatively newly introduced feature of the wet-dry tropics in the Northern Territory that are now widely distributed (Caley, 1993). The full consequences of the introduction of pigs and associated surface disturbance are difficult to quantify as the impacts may only be detected over the long-term (Caley, 1993, 1997; Mitchell et al., 2007a,b).

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Fig. 1. Female pig and litter in the study catchment (2012). Sitings such as this (female and litter) together with sole males are common in the catchment while undertaking fieldwork.

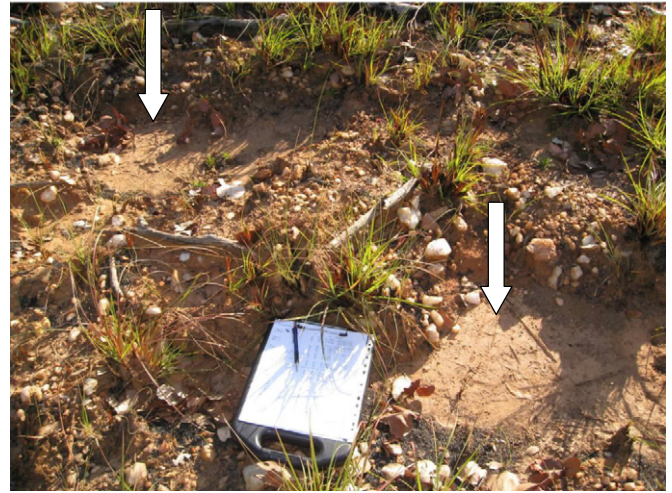


Fig. 3. Fresh pig dig with litter collecting in the base (top) and digs from previous year containing fine sediment (bottom). Arrows added for clarity.



Fig. 2. Large pig digs in the study catchment (2012). The top image displays an exhumation that is one year old (2011) and is located near the creek line on Transect 1a with no freshly exhumed material evident and trapped leaf litter in the base. The bottom disturbance is fresh (2012) and is located near the top of Transect 1a. Note the size and number of quartz cobbles that have been excavated.

Studies by Mitchell et al. (2007a,b) found that there were no significant differences between leaf litter mass, below ground biomass or soil moisture in areas excluded from pigs. Importantly, seedling survival rate was greater when pigs were excluded. Over a 12 year study, Taylor et al. (2011) found that pig disturbance affected seedling density, soil invertebrate density and leaf litter cover. However, there was no effect on soil pH, conductivity, soil invertebrate diversity, tree density or canopy. Other studies (Tisdell, 1982; Alexiou, 1983; Taylor et al., 2011) have found that pig disturbance resulted in increased soil erosion causing rilling and gullying and consequently destabilisation of hillslopes and a decline in water quality.

In areas where there are mines with large disturbed areas that require rehabilitation (such as the Alligator Rivers Region of the Northern Territory), it is believed that pigs may disturb the rehabilitated surface and initiate erosion which may potentially expose contaminated tailings or other material. Given that the animals are relatively new to the environment there are questions over their long-term ecological and biological influence and their influence on soil turnover and, ultimately pedogenesis. Importantly, the study site and region examined here are a repository of biodiversity.

In this study the effect of pig disturbance is quantified in an undisturbed catchment in the monsoonal tropics of northern Australia using both field data and a landscape evolution and soil erosion model. Crucially, landscape evolution models have not been employed in this way previously. Due to its soils and topography the study site

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