



WATER POLLUTION BY AGRICULTURE

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ABSTRACT

Agriculture disrupts all freshwater systems hugely from their pristine states. The former reductionist concept of pollution was of examining individual effects of particular substances on individual taxa or sub-communities in freshwater systems, an essentially eco-toxicological concept. It is now less useful than a more holistic approach that treats the impacts on the system as a whole and includes physical impacts such as drainage and physical modification of river channels and modification of the catchment as well as nutrient, particulate and biocide pollution. The European Water Framework Directive implicitly recognizes this in requiring restoration of water bodies to 'good ecological quality', which is defined as only slightly different from pristine state. The implications for the management of agriculture are far more profound than is currently widely realized.

1. INTRODUCTION

It would be convenient if the component activities of agriculture could be simply and quantitatively related to their impacts on freshwater systems. This would be an ideal basis for creating legislation, for designing incentive schemes to optimize agricultural practice and for minimizing environmental consequences. However, it is far from possible. Both agricultural and freshwater systems are complex and the relationships between them make a mesh of many dimensions. Not least there are many sorts of agricultural system and a plethora of natural waters and communities. The entire land surface, much of which is agricultural, forms the catchment area for one or other river system and almost anything that happens on the catchment has an effect on the freshwaters. The relationship between catchment and receiving water is like that of a house and its waste bin. Most of the activities in the house are reflected in the contents of the bin. In 1979, the Royal Commission on Environmental Pollution (RCEP) published its Seventh Report, entitled Agriculture and pollution (RCEP 1979). Its preoccupations then are familiar still: pesticides, nitrogen fertilizers and organic farm wastes, but the concept of 'pollution' has become the much wider one of 'impact' as understanding has increased of how systems function. Simply to consider how substances emanating from agriculture affect receiving waters, the old concept of pollution, is to misunderstand most of the problem.

2. AGRICULTURE AS KALI AND CERES

Kali is the Hindu goddess of destruction. Agriculture destroys natural, independent systems. It clears natural vegetation and substitutes, for the natural nutrient and soil conservation mechanisms, leaky systems in which nutrient losses to removed crops and by washout from disturbed soils must be continually replaced by fertilizer. It removes the supply of woody debris, eliminates top predators like bears and wolves in the interests of protecting domestic stock and may completely change the complex physical and biological structures of flood plain systems to promote drainage and irrigation. It may favour the increase of particular fish species through nutrient enrichment and cause major disruptions in food webs through altered predator–prey relationships (e.g. Vanni et al. 2005). It introduces novel and alien substances such as biocides to which there has been little time for evolution of defensive mechanisms.

3. POLLUTION IMPACTS OF AGRICULTURE ON FRESHWATERS

In considering the comprehensive impacts of agriculture and how these can be mitigated, it is sensible to define both agriculture and impacts. Agriculture here means modification of the landscape for production of goods that are used for sustenance or market, whether eaten or used in other ways by settled human societies. It thus includes forestry, crop culture, biomass production for fuel and animal husbandry. There is a huge diversity in the intensity to which agriculture is carried out. In turn, ‘impacts’ on freshwater and marine systems means those that result from agricultural change of the landscape. These might include effects on water chemistry (nutrient loss; Haygarth 1997, 2005; Carpenter et al. 1998; Agouridis et al. 2005; James et al. 2005; Mehaffey et al. 2005; Olson et al. 2005) with consequent eutrophication and food web modification (Moss 1996; Pretty et al. 2003; Moss et al. 2004), biocide leaching (Hanazato 2001; Corsolini et al. 2002; Van den Brink et al. 2002; Cold & Forbes 2004; Traas et al. 2004; Christensen et al. 2005), suspended loads from soil erosion (Brodie & Mitchell 2005), alteration of the hydrological cycles (changed evapotranspiration rates and hence run-off and modification of river flows and irrigation water losses; Williams & Aladin 1991), effects of exotic species used, particularly in fish and crustacean culture, and physical modification of the habitat (channelization, channel modification, embankment and drainage; Raven et al. 1998). It is not easy to separate effects of agriculture from those of urbanization.

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5. PROBLEMS IN RELATING AGRICULTURAL ACTIVITIES TO ENVIRONMENTAL CONSEQUENCES

In an ideal world, it would be possible to take an individual agricultural activity, the spraying of a particular pesticide at a known dose rate, the application of a specific amount of ammonium nitrate fertilizer, the stocking of a specified cattle breed at a given density, for example, and measure precisely the effects of these on, respectively, the fecundity of a particular fish species, the growth of aquatic plants in a receiving lake or the extent of silting of a river stretch. The effects can be measured in a general way and modelled with varying degrees of uncertainty (Johnes et al. 1996; Van den Brink et al. 2002; Bowes et al. 2005; Westra et al. 2005; Van Wijngarden et al. 2005), but the sort of precision demanded by legislators and lobbies will never be attainable and this has been a major weapon used to delay regulation of agricultural activities.

CONCLUSION

Water pollution stems from many sources and causes, only a few of which are discussed here. Rivers and streams demonstrate some capacity to recover from the effects of certain pollutants, but lakes, bays, ponds, sluggish rivers, and oceans have little resistance to the effects of water pollution.

