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[Research]

GIS Assessment of site suitability for serial biological concentration (SBC) in Murrumbidgee in Australia

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ABSTRACT
Researchers of CSIRO Land and Water in Griffith in Australia have found a way to repeatedly reuse drainage water to grow crops. In the process the system will concentrate the salt in the water to a manageable level which can then be used or stored in an environmentally friendly manner. The process, known as sequential biological concentration, is based on a novel system for Land, based treatment of secondary treatment of effluent re-use. This research is regional suitability assessment of SBC for Murrumbidgee Irrigation area (MIA) an multiplication SBC suitability Index was developed by reclassifying and assigning suitability factors to groundwater depth, groundwater quality and soil texture data in a raster environment. In this study depth of watertable, groundwater salinity and hydraulic conductivity of soil for the MIA, are achieved by the combination of fieldwork subsequently followed by the Two-dimensional flow and using MODFLOW/MT3D model software. The groundwater depth and groundwater quality were regrouped by the groundwater depth suitability and groundwater quality suitability factors. To determine the regional SBC suitability we used SBC suitability Index. The results of Regional suitability assessment of SBC are presented. Preliminary GIS assessment in MIA shows that thousands of hectares of agriculture land can be benefit SBC technique of managing and exporting salts.

Keywords: Re-use, Serial biological concentration, GIS assessment, Suitability.

INTRODUCTION

Irrigated agriculture occupies approximately 17 percent of the world's total arable land but the production from this land comprises about 34 percent of the world totally. With irrigation, after extended periods, waterlogging and soil salinity usually increases to levels that require intervention (P. wollf and T.M. Stein, 2003). Drainage systems can overcome waterlogging and salinity problems. However, the disposal of saline drainage effluent in arid climates is an issue. River disposal of drainage effluent impacts on river water quality and downstream users. Alternative salt disposal systems within irrigation areas need to be considered as an important management issue in the foreseeable future.

On-farm management of drainage effluent has been considered trialled/adopted in a number of places around the world (JE. Ayars, *et al*., 2007).Soil Irrigation balanced fertilization that has been applied to various crops cultivated on the salt affected with saline water is another option during the past decade. Land treatment of sewage effluent for irrigated cropping and forestry has been successfully used around the world, where the soil conditions are suitable. However, on soils with impeded drainage where the leaching fraction is inadequate, effluent irrigation can lead to waterlogging and Stalinisation. This could reduce crop yields and nutrient removal and hence the long-term sustainability of such sites. Drainage exports salts from irrigated areas, traditionally "disposing" of them to aquifers or watercourses which is no longer aceptable. One common management practice for dealing with drainage water is to use it to

irrigate downstream crops, a short-sighted, short-term solution which merely "exports" the problem. Another option involves the use of evaporation basins to store drainage run _off yet the storage of low salinity water in evaporation pond, without reusing that water where possible, is a waste of a valuable resource.

In recent years the salinisation of water and land in Australia has become an important resource issue. Salinity affects the quality of water in river system and lakes and productivity of agricultural land both irrigated and dry lands as well as the wildlife that find their habitat in the wetlands.

In the irrigation areas in the southern Murray Darling Basin in Australia(see Fig 2), a range of scenarios is being either adopted (conjunctive use of groundwater and surface water) or trialled ,partial conjunctive use and disposal to tree blocks, disposal of pumped groundwater to either 'leaking' or 'sealed' evaporation basins; and Serial Biological Concentration(Ninghu. su *et al*., 2007). SBC is a newly developed management system that is based on the serial re-use of tile drainage effluent, cascading water through series of crops with final containment in a small evaporation basin (see Fig.2).

During the serial re-use cycles the volume of the effluent is reduced while the salinity increases, thus it results in a small volume of highly saline effluent for disposal in a small evaporation basin.

The SBC system has been trialled at 2 sites in the MDB. One site at Griffith is at the Municipal sewerage treatment farm and involves a range of crops, trees and pastures. The other is on an irrigated dairy property at Undera in northern Victoria, using a range of pasture, tree and shrub species. The objective of this research is the determination of regional SBC suitability for Murrumbidgee Irrigation area that the salt in the water in a manageable level can then be used for storing in a environmentally friendly manner.

Study Area

Murrumbidgee Irrigation Area (MIA) part of the Murrumbidgee catchment, is in south-eastren Australia and forms the eastern part of Murray-Darling Basin. It is located about 600 Km southwest of Sydney and 900 km east of Adelaide. The area has two Regional centres; Griffith and Leeton (Fig 1).

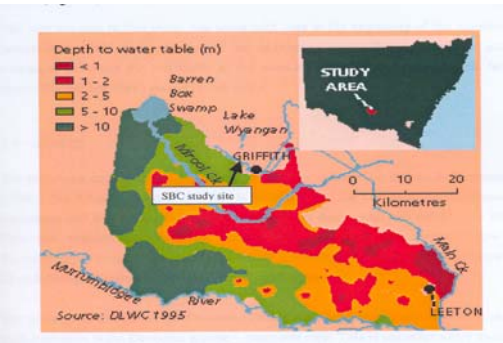

Fig 1. Location map of the study area.

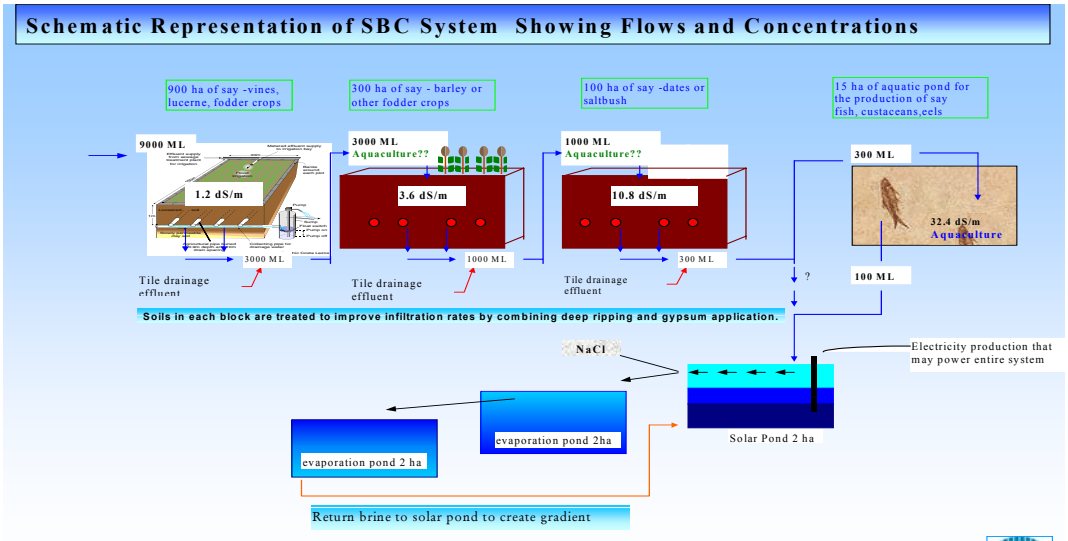

Fig 2. Schematic Representation of SBC system showing flows and concentrations.

MATERIALS AND METHODS

This section provides an evaluation of the SBC sites suggested and some possible alternative locations. There are a number of criteria that relate to this assessment: Firstly, the quality of groundwater below the basin. Secondly, the depth of groundwater that determines the storage available beneath the basin as, opposed to what available laterally. Thirdly, the groundwater gradient and permeability of the aquifer determine the movement from the basin itself (Khan, Shabaz, 2001).

In making this evaluation the following criteria have been used

- Shallow watertable conditions
- Fine textured soils
- Presence of soil salinity
- High salinity of groundwater

Although higher salinity of groundwater is not a prerequisite for the SBC operation, it was included to select those sites where saline groundwater disposal is a major problem and SBC can offer an effective saline effluent management option.

Spatial Assessment of Suitability for SBC

The multiplication SBC suitability index was developed by reclassifying and assigning suitability factors of groundwater depth, groundwater quality and soil texture data in a raster environment (Khan, 2001). The multiplicative SBC suitability factor (F_{sbc}) development is given by this equation.

$$F_{sbc} = F_{gwd} \times F_{gwq} \times F_{st} \quad (1)$$

Where

F_{gwd} = the groundwater depth suitability factor.

F_{gwq} = the groundwater quality suitability factor.

F_{st} = soil suitability factor.

Table 1. Groundwater depth suitability factor (Fgwd) classes.

Groundwater depth (m	Fgwd
<1.5	10
1.5-3.0	5
>3.0	0

Table 2. Groundwater quality suitability factor classes.

Groundwater quality (mg/l)	Fgwq
<1000	0
1000-2000	5
>2000	10

Table 3. Soils types and suitability factor.

Soil Type	Fst
Mountains and hilly soils	0
Sandy Soil	1
Flooded Soil	5
Loamy Soil	7
Salt-affected and clay soils	10

Table 4. SBC Suitability Index.

Category	Fsbc	Description
1	760-1000	Extremely Suitable
2	500-749	High Suitable
3	250-499	Suitable
4	1-249	Marginal

RESULTS

In this study, the data for depth ofwatertable, groundwater salinity and hydraulic conductivity of soils for the MIA are obtained by a combination of fieldwork and modelling using MODFLOW/MT3D Software. The groundwater depth and salinity were regrouped in tables 1 and 2.

Due to the lack of spatial soil data in the study area, hydraulic conductivity data, taken from the groundwater modelling results were used for regrouping soil types. Map of Depth of groundwater in Murrumbidgee irrigation Area are given in Fig.2 Map of Groundwater quality in Murrumbidgee irrigation Area are given in Fig.3 To determine the regional SBC suitability, the SBC Suitability Index (Eq.1) was used. The results of Regional suitability Assessment of SBC, based on table 4 are given in Figure 5.

CONCLUSION

The resulting spatial locations obtained from our considers show there are a part of MIA that is not suitability SBC technique.

The total area of these most suitable locations have SBC Suitability Index between 250-400,and a in small part of MIA there are high suitable area with an suitability index of 500-749.

Preliminary GIS assessment shows that thousands of hectares of agriculture land can benefit SBC technique of managing and

exporting salts. There is good correlation between suitable locations for SBC technique with shallow watertable conditions, fine-textured, soil, and high salinity of groundwater. Recommendate at the first stage it had better apply SBC technique in the limited area and more area could be developed by SBC technology after initial success.

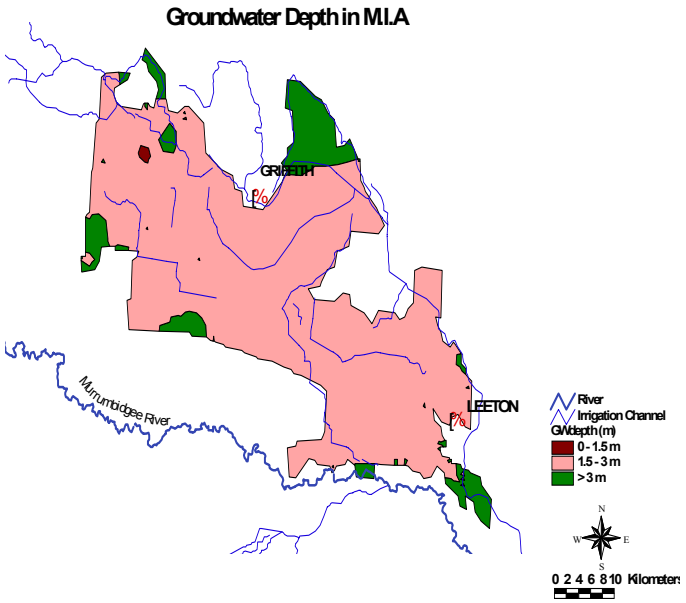

Fig 2. Depth of groundwater in MIA.

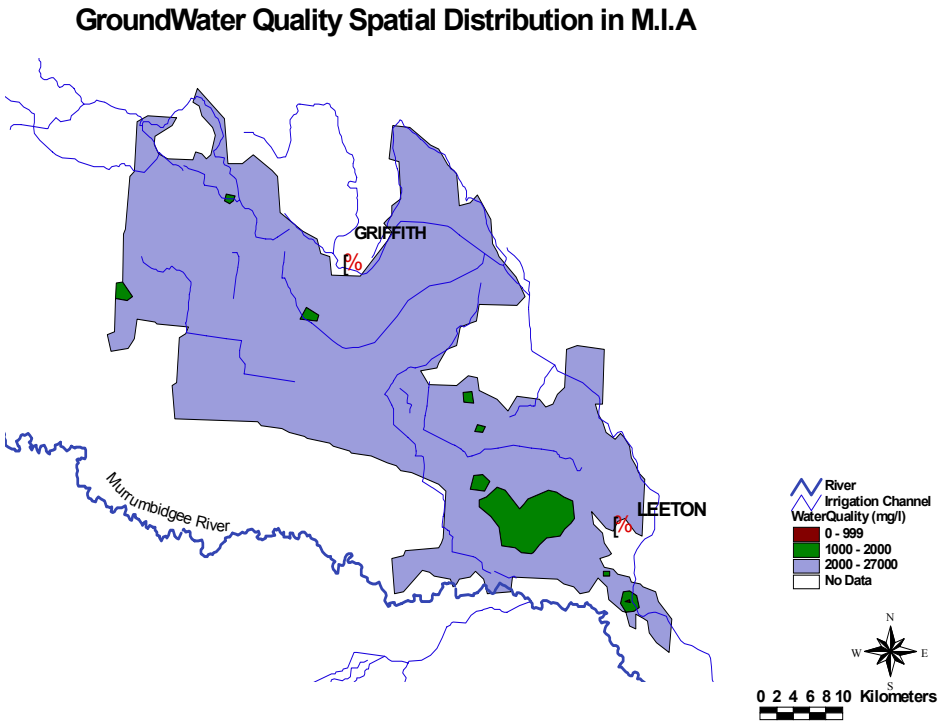

Fig 4. quality of groundwater in MIA.

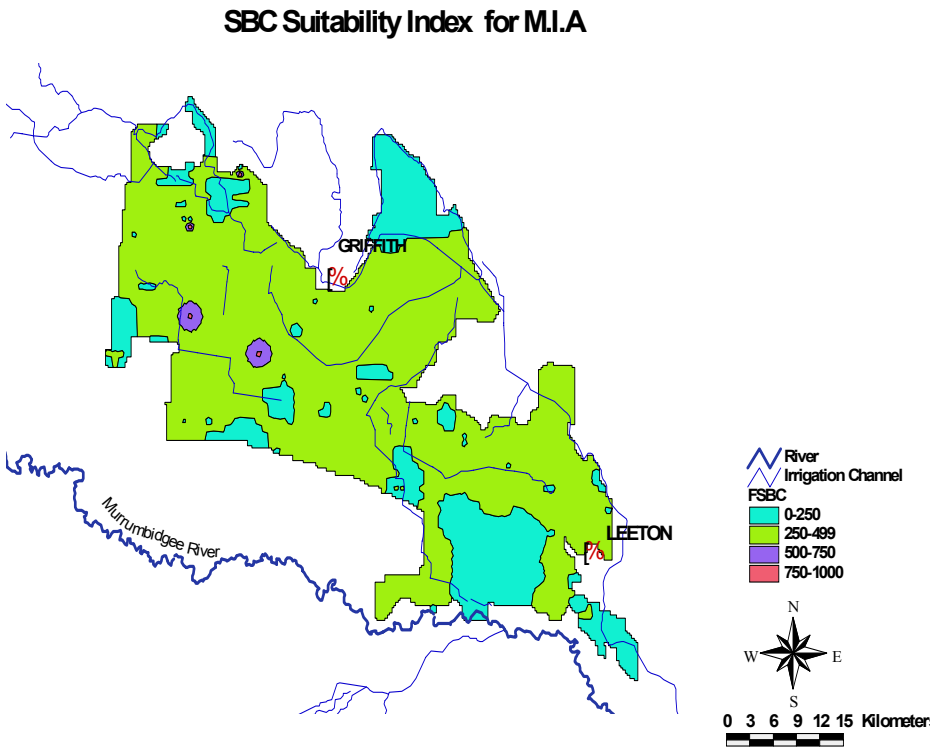

Fig 5. SBC suitability Index in MIA.

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