SECTION 2. Project Justification

2.1 Partner Country and Australian research and development issues and priority

The proposed project originated during the review of LWR1/1995/007, where regional agricultural outputs mainly focussed on the North China Plain. The previous project was conducted by some of the participants of this new proposal. The external reviewers recognised the potential of regional spatial information systems to assess the impact of re-vegetation on ecohydrologic functioning in both China and Australia. In China, key regional outputs from LWR1/1995/007 were the development of some spatial databases in the CSHR and YHB, and further refinement of methods to estimate regional soil erosion from the Loess Plateau. In Australia, key regional outputs from LWR1/1995/007 were developing methods to: (1) map regional moisture availability from thermal regional remotely sensed data; and (2) estimate the average annual regional water-balance based on averaged annual rainfall and the percent of a catchment treed. This proposed project (LWR1/2002/018) builds on those successes.

The Loess Plateau lies in the central west of China, in the middle reaches of the Yellow River, see Figure 1. Actual runoff from the Loess Plateau contributes 24% of the current river volume in the Yellow River, with 83% coming from the Yellow River headwaters (Table 1). The Loess Plateau consists of unique loess hills, sand-loess hills and loess tableland, with many gullies. Winter wheat and summer corn are the main crops, with several orchard fruits (e.g. apples) recently becoming increasingly important to the agricultural economy, and extensive grazing in the northwestern portion of the plateau. Average annual rainfall ranges from to 650 mm (in the southeast) to 200 mm (in the northwest). Thus the Loess Plateau straddles the semi-humid, semiarid and arid climatic zones. Over 60% of the rainfall occurs in the summer monsoon (July to September) season. As rainfall is low and variable, water is the most important factor limiting agricultural production in the region. In the long history of cultivation, natural and social factors have led to a low proportion of vegetation cover, resulting in severe soil erosion, especially at the onset of the intense summer monsoon rains. The severe soil erosion from the CSHR (see Figure 1) has partly filled the Sanmenxia Dam, a major dam on the Yellow River constructed in the 1950's for flood control (Figure 1). The reduced capacity of the Sanmenxia Dam has meant that the dam gates are opened in times of flood, or else water that would flow into the dam could flood Xian. The opening of the dam gates impacts downstream on the North China Plain, where the Yellow River bed is, in parts, 10 m above the surrounding plain, due to the high sediment load carried by the Yellow River.

Table 1. Long-term (1932 to 1990) average annual water amounts in the Yellow River, note 1 TL = 10^{12} L, or 1 TL = 10^{9} m^3. From Prof Dr Mu Xingming's PhD thesis entitled "Impacts of Soil and Water Conservation on River Flow and Soil-Hydrology on the Loess Plateau".

Region	Actual Runoff [4] TL (%)
Above the Loess Plateau [1]	32.1 (83%)
The Loess Plateau [2]	9.1 (24%)
Below the Loess Plateau [3]	-2.6 (-7%)
Yellow River Basin	38.6 (100%)

1 Above Lanzhou hydrological station; 2 Between Lanzhou and Hua-yuan-kou hydrological stations 3 Below Hua-yuan-kou hydrological station; 4 Actual Runoff takes into account extraction of water for irrigation, industrial and urban uses. Note that the region 'Below the Loess Plateau' (or the North China Plain) has a negative runoff as, currently, the river-bed is 3 m to 10 m above the plain, rainfall does not produce runoff, and large amounts of water are extracted from the river for irrigation.

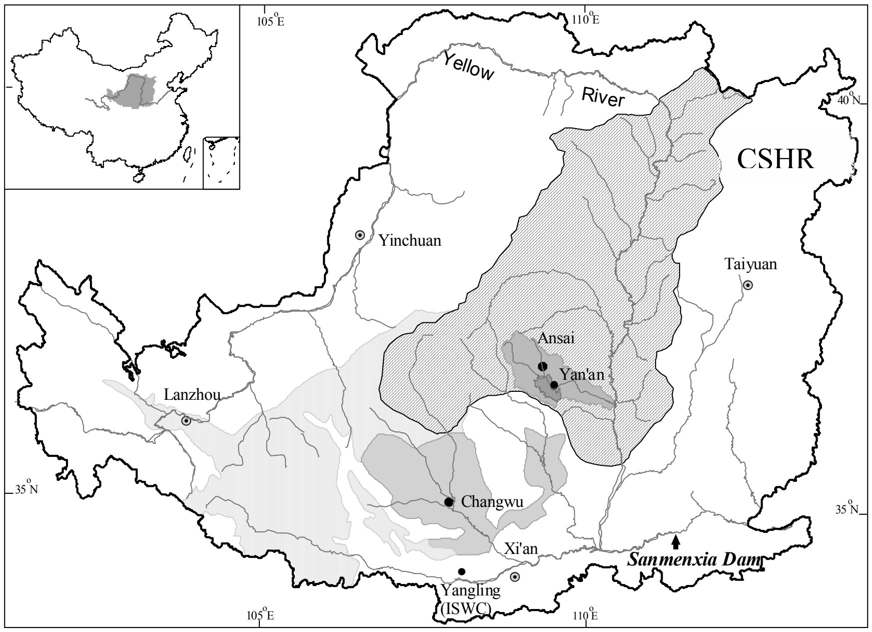

Figure 1. Location of the 707 km^2 Yan'an Demonstration Area (YDA containing Yan'an) contained within the 7,673 km^2 Yanhe Basin (YHB also containing Ansai). The YHB lies within the 134,050 km^2 Coarse Sand Hilly Region (CSHR shown by the hatching) that contributes over 73% to the bedload of the Yellow River. The remaining light grey area (containing Lanzhou) is the remaining Hilly Region, whereas the mid grey shaded area (containing Changwu) is the 31,000 km^2 Tableland Region. The location of Sanmenxia Dam that is filling with sediment is also shown. The 667,000 km^2 Loess Plateau is enclosed by the thick dark line of the main map and shaded grey in the insert map of China.

The current solution to severe erosion on the Loess Plateau is to re-vegetate large tracts of land, including some agricultural land, using perennial plants (grasses, shrubs and trees) where appropriate. Re-vegetation is currently underway with more planned in the Loess Plateau. The aim of the re-vegetation programme is to reduce soil erosion and thus improve water quality of the Yellow River. Re-vegetation is widespread in China; the Chinese Central Government has enthusiastically implemented the "Clean River: Green Hills" policy. This policy will run from 2000 until 2050, hence impacts in the initial stages of the policy have a large potential impact on the policy implementation.

Initially (to 2010), the Chinese Central Government will spend 100 billion Yuan (22.7 billion Australian dollars) to control land degradation. The Loess Plateau is a focus area as it has the highest erosion rates of the entire country. In the Yellow River Basin the Chinese Central Government will subsidise farmers 1,500 kg of grain per hectare per year plus 300 Yuan for each hectare of farmland they re-vegetate. In areas designated for re-vegetation by trees, farmers will receive 750 Yuan per hectare for the first 5 to 8 years. This money will be used to establish nurseries to grow suitable seedlings and to assist farmers to purchase the seedlings. By 2010 in the upper and middle reaches of the Yellow River (including the Loess Plateau), 75% of sloping land and 46% of desert areas will be re-planted using tress, shrubs and perennial grasses depending on climate and landscape position. These figures are sourced from the China People's Daily Overseas Edition, 21 June 2002. The China Central Government is willing to purchase grain for the farmers no longer producing grain; one issue is grain availability. The Chinese Central Government is expected to continue re-vegetation schemes in the mid-term period (2010 to 2030), and they hope to start to see obvious benefits in the final period (2030 to 2050). Results from re-vegetation in YHB will be the backbone for re-vegetation scheme applied to the entire Loess Plateau. Hence developing a readily available Web-based GIS tool during the initial re-vegetation planning stages will have a large impact on the entire 667,000 km^2 Loess Plateau.

In 1999, high-level ACIAR-China consultations specified that water resource management in western China was the issue of highest priority for collaborative research between the two countries. This project fully falls within this priority guideline.

In Australia, salinity and associated waterlogging are major degradation problems facing agricultural practices; the MUMC (see Figure 2) exhibits these issues. Currently there is a strong perception that re-planting trees will solve the salinity problem by reducing excess water entering regional groundwater systems; to 'dry' landscapes and hence reduce the impact of salinity and waterlogging. For example, on 25 May 2002, the Premier of New South Wales issued a media release entitled: "$100 Million Plan to Fight Salinity in Central and South West NSW". In this release, Mr Carr unveiled a new seven-year plan to plant 33,800 ha of trees on land badly affected by salinity. However, runoff and recharge are related, a drying groundwater recharge will dry surface water runoff; hence a balance is required. Research must be conducted to understand the impact of re-vegetating such large areas and determine the impact on surface water. Additionally, given that Australia has the most variable climate of any inhabited continent, the proposed perennial plants used in re-vegetation schemes need to be able to deal with both dry conditions as well as episodic wet conditions, that may still result in regional groundwater recharge. Regional water-balance modelling in Australia for integrated catchment management needs better understanding of the spatial and temporal processes occurring within catchments. To pursue this, regional remote sensing will be used to provide spatially-dense and temporally-dense inputs of key ecohydrologic variables. Including these data sets should allow the regional water balance model to be closed more accurately. This will allow us to better determine the impact of proposed re-vegetation within the MUMC on the runoff component of the water balance.

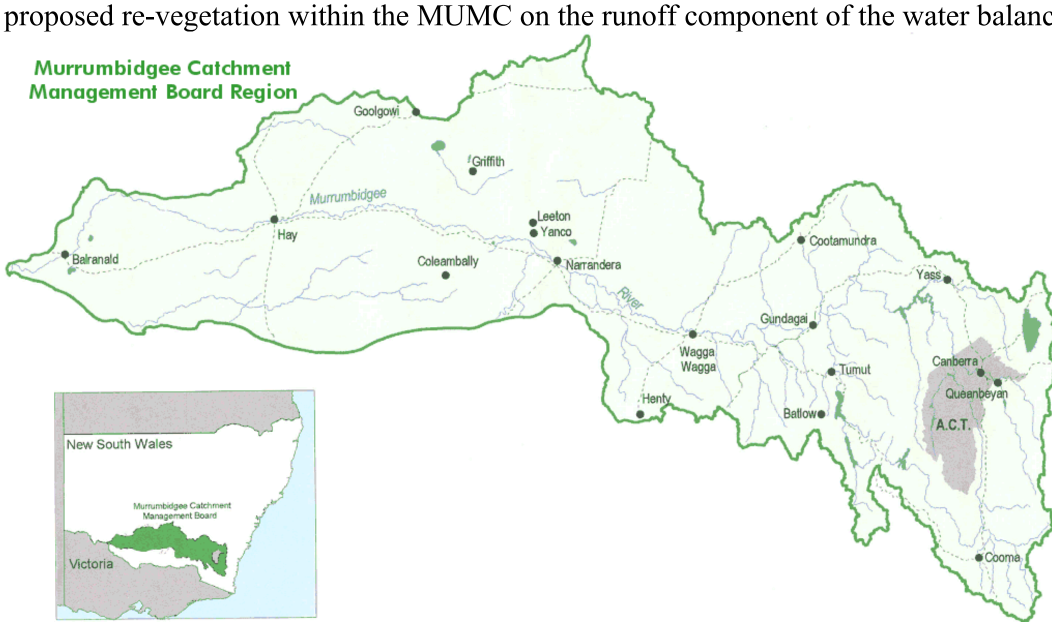

Figure 2. Location of the Murrumbidgee Catchment, the Upper Catchment includes the ACT and extends to Burrinjuck Dam (just southwest of Yass), the Middle Catchment is from Burrinjuck Dam to Wagga Wagga, and the lower portion of the catchment includes the riverine plains that cover the western portion of the catchment. The Middle and Upper Murrumbidgee Catchment (MUMC) is 26, 863 km^2.

In both countries re-vegetation schemes are seen as the solution to different natural resource management problems (reducing erosion in China and drying the landscape in Australia). However, many senior policy makers do not fully understand the impact of the planned large-scale re-vegetation on regional hydrology (see Figure 3). Consequently, research is important to allow those implementing the re-vegetation policy to fully understand the implications of the decisions being made on reducing vital water resources volumes needed for down-stream agricultural production. In China and Australia, the need exists to undertake the development of large area scenario ecohydrological modelling that can be used in a policy setting. In other developing countries (e.g. India) there will also be hydrological impacts from re-vegetation schemes; the methods developed in the proposed project will assist in understanding the regional ecohydrology impact of re-vegetating these other countries.

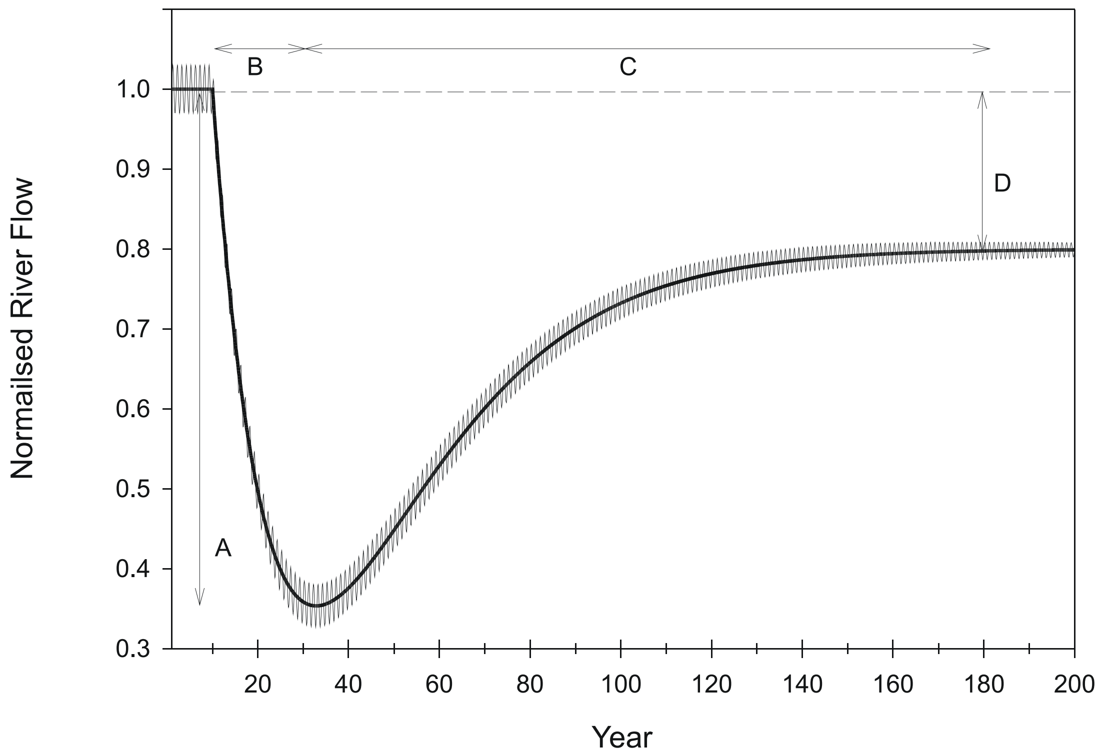

Figure 3. Schematic of normalised annual average river flow (assuming no inter-annual climate variability) when an entire catchment is re-vegetated with trees at 10 years is shown by the thick line when an entire catchment is re-vegetated with trees at 10 years. Segment A is the decrease in annual average river flow that occurs over B years. A new equilibrium is reached after C years with a 20% decrease in average annual river flow, shown by segment D. The thin line represents monthly river flow superimposed on the average annual flow. Note the gradual decrease in the magnitude of the peak flow after re-vegetation compared to peak flows in the first 10 years (prior to re-vegetation).

The technology transfer target audience of the project includes high-level agricultural managers and policy makers. These are specifically identified in Activity 5.1 of Section 3.3 below. In the CSHR, ultimate beneficiaries include most farmers, as many will be impacted by the regional re-vegetation planned by the Chinese Central Government for the Loess Plateau. In the MUMC, the ultimate beneficiaries are mainly farmers in the focus catchment; however, the understanding developed has the potential to influence many agricultural managers' perceived utility of tree re-planting as a management option in southern Australia. These are both expanded in Section 4 below.

2.2 Project context (relationship to previous ACIAR research and other research) and research strategy

The proposed research approach is based on three stages: firstly, we will finalise the development of the required spatial databases; secondly spatial, models will be developed with predictive capability; and finally the model will be ported to a Web-based GIS delivery framework. Various scenarios of future potential changes in land cover will be modelled allowing mid and senior policy makers and managers to understand the implications of the proposed policies. Currently, few spatial models have been made accessible for agricultural policy makers to assess the regional ecohydrologic impacts of re-vegetation. Hence, these models have had little impact on decisions. We plan to extend current models, validating the performance, and then develop a Web-based tool to support decisions made by regional agricultural policy makers, hence impacting their decision making process. User suggestions and inputs will be solicited and implemented throughout the entire project period. We will meet with Chinese users, identified in Activity 5.1, in the first three months, and every year after that. Additionally an e-mail distribution list will be established to ensure end-users are kept up to date with project developments. The final system will be launched during the final review meeting / workshop in China.

In China, ISWC have been researching aspects of regional water balance and its relationship to land use change since the early 1980s. They have developed long-term databases of land-use change. In this project, a goal is to extend this monitoring experience with the aid of suitably detailed processes understanding to provide the ability to perform predictive spatial modelling. By performing this applied project, ISWC project staff will develop skills to allow model and Web-based delivery development to progress after the project is complete. Senior members of the LWR1/2002/018 project team involved in a previous successful ACIAR project (LWR1/1995/007), have the scientific resources, including spatial-temporal databases (see specifically Sub-Project 1 and Activities 1.1, 1,2 and 1.3), to pursue the spatial modelling. Other members of the team possess the ability to develop and deliver a high-end Web-based modelling tool to impact senior agricultural policy makers.

Australian researchers involved in LWR1/2002/018 have developed several spatial information systems addressing agricultural issues such as: (1) regional moisture availability mapping; and (2) assessing ecohydrological impacts of land-cover change on an average annual basis. Strong links have developed between the spatial information scientists and regional ecohydrologists; LWR1/2002/018 will further strengthen these interactions. In CRC_CH project 1A (the "Toolkit") there is strong software engineering experience and LWR1/2002/018 will have formal access to these skills. The LWR1/2002/018 appointed staff member will liase with a CRC_CH software engineer and be involved in software development for both China and Australia. This will ensure that software development procedures meet current best practice programming and avoid re-inventing modules already developed as part of the CRC_CH Toolkit.

Activities in Australia are planned to strongly link with several CRC_CH projects to deliver readily usable tools to agricultural / catchment policy makers in Australia. Specifically, LWR1/2002/018 will link with the next round (2003-2007) of CRC_CH projects, including water balance projects (5A and 3A), the catchment integration project (1B), and as discussed previously, the "Toolkit" project (1A). On 30 July 2002, Dr Rob Vertessy (Director CRC_CH) informed LWR1/2002/018 project proponents that at the 29July 2002 CRC_CH

Board meeting, the Board provided in-principle support for the CRC_CH projects abstracts that LWR1/2002/018 would link with.

A CSIRO Earth System Science (ESS) Post-Doctorial Project (PDP), resulting from a joint proposal by Dr Edward King (CSIRO Earth Observation Centre) and Dr Tim McVicar, was recently approved. The aim of this PDP is to make consistent best-practice corrected AVHRR data available for all Australia. Late in 2003, 1-km resolution AVHRR data from April 1992 will be made available to LWR1/2002/018. Consequently LWR1/2002/018 will be a beta test site (hence getting quality AVHRR data as early as possible) of the delivery system developed by this ESS PDP. The PDP will commence in January 2003 for three years, the same time frame as LWR1/2002/108. There is also potential to develop links to 'Heartlands', a CLW led project.

In addition to LWR1/1995/007, there are several other ACIAR projects relevant to this proposal. LWR2/1996/143 ("Sustainable mechanised dryland grain production") worked on conservation tillage and controlled traffic systems to enhance rainwater use and reduce erosion in Shanxi, east of our study area. LWR2/1999/094 ("Improving the productivity and sustainability of rainfed systems for the western Loess Plateau of Gansu Province") aims to develop improved farming practices to protect soil resources, improve water use, and raise crop yields and farm profitability. LWR1/2002/018 is focused on hilly areas in the heart of the Loess Plateau and is taking a regional approach whereas the two LWR2 projects have been directed at farm level soil and water management in flatter areas. There are also two technical water-related projects in the Yellow River Basin: LWR1/2000/030 ("Growing more rice with less water: Increasing water productivity in rice-base cropping") aims to promote improved water management in rice growing areas well downstream of the Loess Plateau. Project LWR1/1998/130 ("Water resources and salinity management in agricultural areas of inland Northern China and Northern Australia") is directed to managing groundwater to reduce salinisation west of the Loess Plateau in Ningxia.

LWR1/2002/018 will have strong links with an associated ACIAR project FST/1997/077 though Dr Lu Zhang being a researcher common to both projects. FST/1997/077 aims to assess the impact of Eucalypt plantations on water use in Leizhou Peninsula in Guangdong Province in southern China. The proponents of LWR1/2002/018 are aware of the proposed ACIAR project, ADP/2000/120 ("Institutions and policies for improving water allocation and management in the Yellow River Basin"). LWR1/2002/018 will develop methods to study the ecohydrological impacts of re-vegetation for the 7,673 km^2 YHB and the 134,050 km^2 CSHR of the Loess Plateau; only biophysical databases will be established in LWR1/2002/018. Given planned implementation of the Chinese Central Government "Clean River: Green Hills" policy throughout the Yellow River Basin (indeed all China), the methods developed by LWR1/2002/018 could feed into ADP/2000/120. Links between LWR1/2002/018 and ADP/2000/120 will be explored when appropriate.