OVERLAND FLOW – WHAT IS IT?

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ABSTRACT

Put simply, overland flow is rainfall-induced runoff. However, little about water policy is simple and clear differences in definition and interpretation exist between states in the Murray-Darling Basin. The definition of overland flow has been debated but a national definition of overland flow has yet to be agreed upon. Queensland and New South Wales, the major states who irrigate water sourced from overland flow, currently have differing definitions and specific inclusions/exclusions of the various components. This paper discusses the different definitions of overland flow, what it is and what it isn't, and examines the importance of overland flow to irrigation in Queensland and northern New South Wales. The paper also discusses the importance of the definition of overland flow in the Murray-Darling Basin and its role in the integrity of the cap on diversions from within the Basin. The different components of overland flow are identified and discussed and a new term - Land Surface Diversion - is proposed to provide a uniform definition for use across the Murray-Darling Basin.

INTRODUCTION

The Cap on diversions agreed by the Murray-Darling Basin Ministerial Council (Council) in 1995 is a critical policy measure to achieve healthy rivers and sustainable consumptive uses. The two primary objectives driving the decisions to implement the Cap were to:

- Maintain and, where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin (MDB) to protect and enhance the riverine environment, and
- Achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs.

In August 2000, the Council agreed to the recommendations of the Review of Operation of Cap, which included:

- *All forms of water use be incorporated in Cap management arrangements as they are recognised and can be quantified* (Recommendation 12);
- *Diversions from floodplain and overland flows are included in Cap accounting arrangements as a matter of priority* (Recommendation 14).

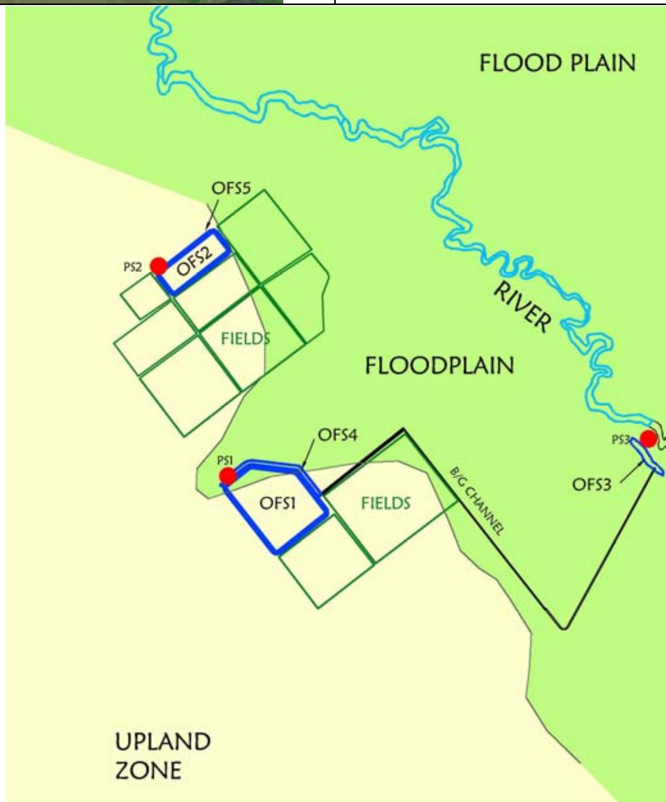
A recent study (Bewsher Consulting, 2006) has found that the term - "floodplain harvesting" - does not have a consistent meaning across NSW, QLD and the Murray-Darling Basin Commission (MDBC). The scope of the related term "overland flow take" in Queensland is broader and practically includes all diversions other than those directly from rivers, lakes and billabongs. NSW uses terms such as floodplain harvesting, overland flow harvesting, rainfall run-off harvesting and differentiates between these different components of "non-stream diversions" based upon the location, origin and use of such water.

Bewsher Consulting (2006) has recommended adoption of a consistent term of "Land Surface Diversions" (LSD) to encompass all forms of surface water diversion except the direct extractions from rivers, watercourses, lakes and billabongs. Floodplain harvesting, overland flow harvesting, rainfall run-off harvesting and hillside farm dam harvesting have been identified as components of "Land Surface Diversions".

EXAMPLES OF OVERLAND FLOW

Extraction of overland flows is practised widely in the Queensland and northern NSW section of the Murray-Darling Basin. However, it is poorly understood elsewhere within the catchment. Two examples are given below of typical irrigation schemes that are based on overland flow diversions.

The photographs and map above show an irrigation property on the Darling Downs. It is not within the floodplain of a watercourse. The irrigation scheme collects water from off-farm and on-farm overland flow is collected in a sump and stored in a ring tank. Irrigation is also supplemented with groundwater allocation.



The photographs and map above show another irrigation property on the Darling Downs. This property is partially within the floodplain and, as such, collects flood water breaking out from the river. It also collects off-farm and on-farm overland flow. All flows are collected in sumps and pumped into ring tanks. Irrigation water is also supplied through waterharvesting from the river (non-overland flow).

IMPORTANCE OF LAND SURFACE DIVERSION TO IRRIGATION IN NORTHERN MDB

Bewsher Consulting (2006) found that the Land Surface Diversions form 20-30% of total diversions from river valleys in the northern NSW and southern Queensland areas of the Murray-Darling Basin. FSA Consulting regularly deals with individual properties in southern Queensland that source up to 80-90% of their irrigation water from Land Surface Diversion. Generally speaking, irrigators in southern Queensland source a greater proportion of their irrigation water from Land Surface Diversion than irrigators in northern NSW. This is because the MDB river systems in southern Queensland are less regulated through major in-stream storages than northern NSW.

This dependence on overland flow is reflected through the development of guidelines that specifically deal with works that take overland flow in Queensland (NRW, 2008). These guidelines are implemented through the Water Resource and Resource Operations Plans for Queensland catchments. NSW currently does not have equivalent guidelines for works that take overland flow and there is a lack of consistency that arises especially for catchments that lie across the border between Queensland and NSW.

MEASUREMENT OF LAND SURFACE DIVERSION

Bewsher Consulting (2006) noted that monitoring and quantifying Land Surface Diversions is very challenging, as there are practical difficulties in separating different components of diversions and estimating them accurately. For example, an on-farm storage could receive water from rivers, external catchment runoff, tail-water from irrigated areas, runoff from within the farm or floodplain flows resulting from the overflow of nearby watercourses. Traditional metering of such water supplies, which is based upon pumping, is problematic as diversions do not always rely on pumping, or when pumps are used, the source of the water can vary. Consequently both States have been unable to develop an accurate system for reporting the Land Surface Diversions. The inadequacy of current methods of measuring and monitoring Land Surface Diversions poses severe limitations on existing and proposed policies in both States for managing such diversions. Development of an improved procedure for monitoring and reporting of Land Surface Diversions has been recommended.

The integrity of the Cap process is dependent upon the existence of an accurate, reliable and integral system of water diversion data collection, estimation, storage, and reporting. As such, the Cap process is undermined due to a significant lack of accurate information regarding Land Surface Diversion (which is potentially a significant proportion of total MDB diversions). In addition, the national implementation of water metering/accounting will be impeded by a lack of agreement over Land Surface Diversion.

NEED FOR A DEFINITION

It is self-evident that, before recommendations can be made on the most appropriate methods for measuring Land Surface Diversion, a clear definition of what needs to be measured is needed. This definition should include:

- What is Land Surface Diversion and what is not Land Surface Diversion?
- Where should it be measured?
- What units of measurement and over what time period?
- What measurement accuracy is required?

Only after these issues are agreed upon can measurement proposals be prepared.

PROPOSED DEFINITIONS

FSA Consulting, in conjunction with Aquatech Consulting, presented the following definitions to a MDBC committee meeting (15 March 2007) as part of a study undertaken for MDBC (FSA Consulting/Aquatech Consulting, 2007) and these were discussed in detail following a field inspection of several irrigation farms.

<u>Underlined</u> terms used in some definitions, e.g. <u>runoff</u>, have their own individual definitions.

Land Surface Diversion (LSD)

Land Surface Diversion is the <u>diversion</u> of <u>runoff</u> into an <u>on-farm storage (OFS)</u> or for direct irrigation thus preventing that <u>runoff</u> from naturally entering a <u>watercourse</u> or infiltrating into the <u>floodplain</u>. LSD is to be measured (or estimated) at the <u>Point of Take</u> and at the <u>Point of Exit</u>.

> Comment: This definition is as generic as possible and covers all types of land surface diversion irrespective of the source of the water (runoff). This definition specifies where LSD should be measured. This definition is not limited to irrigation-farms.
>
> This definition recognises that the final, natural destination of land surface diversions (particularly overflows from watercourses) is not always to return to a watercourse. The final destination of some floodwaters is inundation into dry floodplains and it is this water that graziers in northern NSW claim has been lost due to excessive land surface diversions.

Annual Farm Land Surface Diversion (AFLSD)
Annual Farm Land Surface Diversion is the net volume of LSD taken by the farm at the Point of Take less the LSD lost at the Point of Exit in one year. AFLSD is expressed as ML/yr.

Mean Annual Diversion (MAD)
Mean Annual Diversion is the long-term average volume of LSD taken by the farm at the Point of Take less the LSD lost at the Point of Exit over a prolonged period. MAD is expressed as ML/yr.

> Comment: MAD is a term used in the Queensland system and could be interpreted to represent an “allocation” or “right” of LSD for the farm.
>
> Mean Annual Diversion is determined through hydrological modelling / simulations and is an approach taken by NR&W in Water Resource Plans.
>
> Mean Annual Diversion, otherwise known as ‘share of the resource’, refers to the estimation of the total water resource available in a catchment. The share of this resource may be specified in terms of mean annual diversion, which is defined as the total volume of water simulated to have been taken under the authorisation or authorisations, if the authorisation or authorisations were in existence for the whole of the simulation period, divided by the number of years in the simulation period.

Diversion
Diversion is the movement, by gravity or pumping, of water from the natural environment to on-farm storage or direct irrigation.

> Comment: This definition is very similar to that given in NSW Government (2005) where ***Diversion*** is “the diversion of water away from its normal or natural flow path or location in a water source. It may be returned to the water source after being used for non-consumption purposes”. (If it is diverted away from its source for consumptive purposes, it is referred to as ***Extraction***.) Extraction is then defined as “the diversion of water away from its normal or natural path or location in a water source, for consumptive purposes.”

Diversion Losses
Diversion losses is the difference between the volume of water diverted at the Point of Take and the volume of water applied directly for irrigation or available in an on-farm storage and/or lost at the Point of Exit.

> Comment: Diversion losses recognise that diverted water may evaporate or seep into the land surface after it is taken from the natural environment and is thus not available for irrigation or storage. Hence, measurement of LSD at a storage may not be the actual net LSD taken from the natural environment.

Floodplain Harvesting (FPH)
Floodplain harvesting is the diversion of water flowing across a floodplain. Floodplain harvesting applies to those flows that have originated from a watercourse and breakout during a flood (this includes the capture of receding flood waters). FPH is LSD.

> Comment: This is a modification of a definition used in NSW and is not used in Queensland. However, it may be useful if the source of LSD is needed.

Rainfall Runoff Harvesting (RRH)
Rainfall runoff harvesting is the diversion of runoff from areas of the farm that have been developed for irrigation. RRH is LSD.

Comment: This is a modification of a definition used in NSW and is not used in Queensland. However, it may be useful if the source of LSD is needed. Rainfall runoff harvesting does not include the diversion of tailwaters.

Tailwater (TW)
Tailwater is excess irrigation water flowing from paddocks as a direct result of irrigation. Tailwater is not LSD.

Overland Flow Harvesting (OFH)
Overland flow harvesting is the diversion of rainfall runoff from land surfaces other than the farm's irrigation areas. OFH is LSD.

Comment: This is a modification of a definition used in NSW and is not used in Queensland. However, it may be useful if the source of LSD is needed.

Farm
The Farm is the property area that is operated as one unit with respect to water allocation and licensing issues.

Runoff
Runoff is water that runs across the land surface resulting from excess rainfall, breakout from watercourses or spring-fed either before it enters a watercourse or before it infiltrates into the floodplain.

Runoff includes:

a) Rainfall runoff, which is runoff caused by rainfall on the land surface
b) Floodplain runoff, which is movement of floodwater after it leaves a watercourse
c) Spring-fed runoff, which is runoff after it rises to the land surface naturally from underground.

Runoff does not include:

a) Water contained in watercourses or lakes (including billabongs)
b) Water that has naturally infiltrated the soil during normal farming operations including infiltration that has occurred in farming activity such as clearing, replanting and broadacre ploughing
c) Tailwater directly resulting from irrigation
d) Water collected from roofs for rainwater tanks.

Comment: This definition is taken largely from the Queensland definition of Overland Flow. Overland Flow is defined as "water that runs across the land after rainfall, either before it enters a watercourse, after it leaves a watercourse as floodwater, or after it rises to the surface naturally from underground". An extended definition of overland flow water is provided in the Water Act (2000). It excludes water contained in watercourses or lakes (including billabongs), water that has naturally infiltrated the soil during normal farming operations, tailwater directly resulting from irrigation and water collected from roofs for rainwater tanks. Overland flow water that was previously in a watercourse is defined as floodwater, and taking this water is known as "overland flow take (floodwater)".

One issue arises with the exclusion of "water that has naturally infiltrated the soil during normal farming operations" from the definition of runoff as this could be construed to exclude water that saturates a floodplain following a flood event.

Lake
A Lake includes:

a) A lagoon, swamp or other natural collection of water, whether permanent or intermittent
b) The bed and banks and any other element confining or containing the water.

Watercourse
A Watercourse means a river, creek or stream in which water flows permanently or intermittently:

a) In a natural channel, whether artificially improved or not
b) In an artificial channel that has changed the course of the watercourse.

A watercourse includes the bed and banks and any other element of a river, creek or stream confining or containing water.

Land Surface
The Land Surface is all parts of the catchment other than the watercourse or lake.

Floodplain
The Floodplain is that part of the land surface that is covered by a flood that occurs, on average, once every 100 years.

Upland Zone
The Upland Zone is that part of the land surface not classed as floodplain.

Point of Take
Point of Take is the position (physical location) on the land surface where runoff is diverted from the natural environment to a controlled environment for later use. This may be a defined point or distributed line.

Point of Exit
Point of Exit is the position (physical location) on the land surface where runoff is returned to the natural environment from a controlled environment. It is where excess LSD is released (lost) from a farm at a point often referred to as a “blow-out”. This may be a defined point or distributed line.

Rate of Take
Rate of Take is the rate of diversion of runoff at the Point of Take and is expressed as ML/day.

Comment: The Rate of Take can be “**Controlled”** (where the flow is through a pipe or defined channel and is of relatively constant rate) or “**Uncontrolled”** (where the flow is taken at a variable rate and not through control structures). Uncontrolled take is storm runoff into a gully dam or floodplain breakout flows into an open surge dam.

On-farm Storage (OFS)
An on-farm storage is any privately-owned storage where the intended use is to store water. An on-farm storage does not include:

a) Lakes that were not used for irrigation or other intensive production
b) Land being used for agriculture, including irrigation or dryland areas, including areas surrounded by levee banks designed to prevent the land becoming inundated (for example, bunded land on the floodplain) where the intended use of the structure (levee bank) is to exclude floodwaters
c) Infield storages.

Comment: In Queensland, an OFS is a dam that is defined under Water Act (2000) as:

(a) Works that include a barrier, whether permanent or temporary, that does, could or would impound water

(b) The storage area created by the works.

The act also states that a dam includes “an embankment or other structure that controls the flow of water and is incidental to works” mentioned above Water Act (2000). Based on this definition, the following would be classified as a dam under the Act:

Ring Tank
Gully Dam
Hillside Storage
Excavated Dams
Lake
Surge Dam
Sump
Weir
Channel / Drain

Levee Protected Areas
Levee protected areas are those areas within the floodplain that are protected from inundation during a flood by a series of man-made levee banks.

In Queensland, the Code for Assessable Development for Operational Works for Taking Overland Flow Water (NR&M, 2005) states that an application to make changes to existing works must not involve the reconfiguration of the storage capacity of any of the following:

a) Lakes that were not used for irrigation or other intensive production
b) Land being used for agriculture, including irrigation or dryland areas, including areas surrounded by levee banks designed to prevent the land becoming inundated (for example, bunded land on the floodplain) where the intended use of the structure (levee bank) is to exclude floodwaters
c) Infield storages.

This definition prevents structures such as bunded areas and levee banks from being included in Land Surface Diversion estimation.

Comment: Bunded areas (land behind a levee bank protected from flooding) are a particular issue in some irrigation areas. These irrigators claim that, in the natural condition, floods would saturate their land. By protecting their land with a levee bank, they are preventing this infiltration from occurring and thus they are losing water that they would be naturally entitled to.

CONCLUSIONS
Overland flow, or Land Surface Diversion as described in this paper, is a significant component of extractions from the Murray-Darling Basin (MDB). However current definitions of Land Surface Diversion are inconsistent between Qld, NSW and the Murray-Darling Basin Commission.

Land Surface Diversion is challenging to measure and to date no formal measurement of this extraction of water exists within the MDB. Therefore the cap on extractions from the MDB is undermined due to a significant lack of accurate information regarding Land Surface Diversion. Furthermore, NSW does not include Land Surface Diversion in cap reporting.

However, without consistent agreement across the MDB on what Land Surface Diversion is, and more importantly, what it isn’t, accurate measurement cannot occur.

A definition of Land Surface Diversion (along with other supporting definitions) was proposed for adoption of what Land Surface Diversion is. Land Surface Diversion is the diversion of runoff into an on-farm storage (OFS) or for direct irrigation thus preventing that runoff from naturally entering a watercourse or infiltrating into the floodplain. LSD is to be measured (or estimated) at the Point of Take and at the Point of Exit.

FUTURE WORK

FSA Consulting and Aquatech Consulting are undertaking a project on behalf of MDBC to develop measurement technologies for LSD. The project involves the instrumentation of six irrigation farms across the northern section of the MDB and will run for about two years. The outcome of the project hopefully will be viable methods for measuring or estimating the take of LSD from the MDB.

REFERENCES

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