

Managing Irrigation Dams with Sterile Grass Carp

Introduction

Aquatic weeds can clog irrigation systems and disrupt the ecology of dams. Some aquatic weed in dams is beneficial as they trap sediments and utilize excess nutrients making water clearer in the dam. The aquatic plants are themselves providing shelter and food for fishes and other animal life in the dam. However, too much weed can be a problem which requires effective management. One of best tools (and environmentally friendly too) to manage aquatic plants is to stock dams with sterile grass carp (*Ctenopharyngodon idella*). With the development of technology to breed sterile grass carp, a valuable management tool was created to manage our scarce water resources. With the consequent development of production and stocking protocols in South Africa, it is much easier today to obtain quality sterile grass carp and make informed decisions as to stocking rates, than was the case in the past. Grass carp is an affordable option to control aquatic weeds. Note that grass carp is a completely different fish to the well-known carp, (*Cyprinus carpio*), the latter often causing water quality problems when stocked into dams and rivers.

From research done in the U.S.A. and our own experience here in South Africa, an average working population of 30 fish per ha (10 000 square meters) of water is usually stocked into dams. These stockings will largely be determined by the following factors:

- Surface area of the dam
- The type (species) of weeds present
- The percentage of weed infestation of dam surface area
- Fish size (smaller fish are stocked at higher densities to compensate for mortalities)
- Water use
- Time frame for aquatic weed control

Grass carp act as a mechanism to remove aquatic plants from water bodies. They do not make a significant contribution to remove excessive nutrients in water. Other management strategies must be implemented to complement an integrated approach to aquatic weed problems.

The correct application of sterile grass carp is not only a valuable tool in the management of aquatic weeds, it is the added benefits that are worth considering.

Markets

With overseas markets becoming more and more sensitive about the quality of our waters and the chemicals we use, grass carp is an effective biological agent in the war against aquatic weeds. Copper based compounds, like copper sulfate, have been used extensively in the past to facilitate water flow in

irrigation systems. Copper can be hazardous to fish species and aquatic insects, and thus needs to be used with caution. Furthermore copper build up in irrigation soils and may reach toxic levels over time.

The gradual buildup of chemical compounds like these in dams can cause serious problems for farmers wanting to conform to market accreditation processes, like Global GAP, etc.

Evaporation

Being a semi-arid country, our water resources will become more and more threatened. We are already seeing the effects of a serious drought this year in our summer rainfall regions. The average evaporation factor for the country is between 1.8 meters to 2.3 meters per year. This means that the average dam loses 5 to 6 mm of water on average every day, due to evaporation.

Aquatic weeds in our dams heat the top water layer of dams by as much as four degrees Celsius. The rate of evaporation therefore increases incrementally. The rate of evaporation is determined largely by the following factors:

- Surface water temperature
- Water surface area in relation to depth
- Air temperature
- Wind factor
- Humidity
- Concentration of aquatic plants in water body contributing to evapo-transpiration

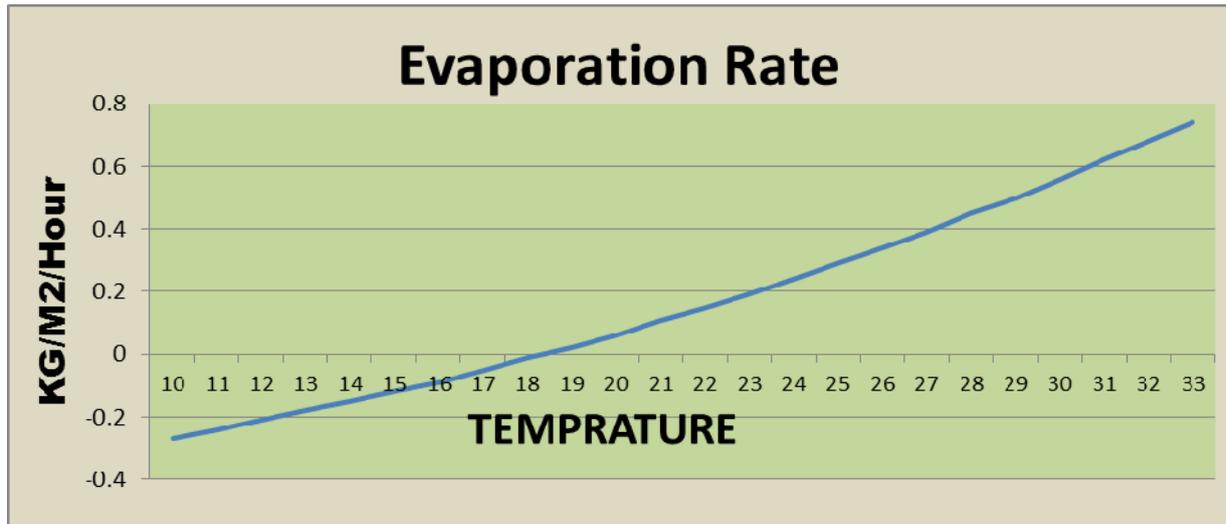
As evaporation itself draws a lot of energy from the environment, it serves as a cooling process and therefore cools down the water temperature of dams. By allowing dams to be infested with aquatic weeds, we are contributing to an increase in water temperature and therefore evaporation and hence we are losing precious water.

The evaporation rate will vary constantly, influenced by the effect of changing environmental factors. By managing your weeds, you can save as much as 7.5% of your dams holding capacity per month depending on water depth. Should you need to replenish your water losses by pumping water from another source, this could mean a significant slice of your electricity bill could be saved.

As can be seen on the evaporation calculation and the graph below the difference in evaporation between the surface temperature of 24 degrees Celsius and 28 degrees Celsius is 210 ml of water per square meter, per hour. (Other factors remaining constant) This adds up to 21,000 liters of water for a ten hour period per ha/ day.

Water Temperature	Air Temperature	Humidity	Wind Velocity	Evaporation Rate (kg/m²/h)
10	30	50	10	-0.27
11	30	50	10	-0.24
12	30	50	10	-0.21
13	30	50	10	-0.18
14	30	50	10	-0.15
15	30	50	10	-0.12
16	30	50	10	-0.09
17	30	50	10	-0.05
18	30	50	10	-0.01
19	30	50	10	0.02
20	30	50	10	0.06
21	30	50	10	0.11
22	30	50	10	0.15
23	30	50	10	0.19
24	30	50	10	0.24
25	30	50	10	0.29
26	30	50	10	0.34
27	30	50	10	0.39
28	30	50	10	0.45
29	30	50	10	0.5
30	30	50	10	0.56
31	30	50	10	0.62
32	30	50	10	0.68
33	30	50	10	0.74

Source: <http://apps.acpa.org/apps/EvaporationCalculator.aspx>



The water usage for the average household in South Africa is estimated at 250 liters per day. In other words, the loss of water due to evaporation for a one hectare dam infested with weeds is enough water for 84 households per day. Taking into account the amount of weed infested dams in South Africa; the loss of water due to unnecessary evaporation is a staggering amount.

Evapotranspiration

With the spread of emergent aquatic plants in a dam (pondweed, parrots feather), the loss of water is increased by evapotranspiration of the plants in the dam. (Evapotranspiration is the combined loss of water through evaporation and aquatic plant transpiration.) The evapotranspiration of weeds vary due to physical characteristics and other factors like wind.

From research conducted in India as far back as 1973, it was established that the evapotranspiration of water hyacinth was 3.7 times higher than the evaporation from a free water surface. As far as submerged aquatic vegetation is concerned, this massive evaporation rate is only surpassed by American pondweed (*Potamogeton nodosus*).

Reeds are also a big contributor to water loss via evapotranspiration. It was established by aquatic scientists that the evapotranspiration rate of reeds such as *Phragmites* was 7 to 10 times higher than evaporation from a free water surface.

Various species of pondweeds occur in South Africa and combined, they are responsible for the largest portion of infestations of aquatic weeds in ponds and dams. They are distributed throughout the country.

Water accessibility

With a drop in water levels, the evaporation rate will increase as the plant biomass in the remaining water becomes proportionately more and more. The water will also become increasingly inaccessible as

it will become more difficult to extract water from the dam at low levels. In years with less than normal rainfall, this can pose a serious problem.

Dissolved Oxygen Levels (DO)

Heavy infestations of aquatic plants reduce wave action in dams significantly. Combined with a high rate of respiration during the night, the DO levels can fluctuate excessively during a 24 hour period. This in turn will have a negative impact on the ecology of a dam. It will impact on fish and the quality of angling of the dam.

Eco Tourism and angling

A large amount of farms have added eco-tourism and angling to their activities. With clogged up dams, no water sport activities can be practiced. Some of our best private and public waters are now threatened by rapidly increasing weed problems making boating and angling difficult. This is partly due to the fact that lower dam levels concentrate nutrients. Unchecked pollution of the water resources will increase the problems, increasing aquatic weed levels and put some communities at risk.

Water odour and taste

When plant matter decomposes, gasses like hydrogen sulfide and methane are formed. These are by products of bacterial breakdown of plant matter. These gasses are responsible for an obnoxious taste and smell in water. During periods of low DO, this can lead to anaerobic conditions in water bodies and make it unfit for human and animal consumption. It can also lead to fish kills. This phenomenon is in most cases associated with low dam levels and pollution with organic material.

Property value

From research done in the USA, the value of shoreline properties can be decreased by 13% and more, if waterways and dams are clogged up with aquatic weeds. In up-market lifestyle resorts and housing developments, the impact could be significantly higher. For this reason, grounds men and estate managers are very aware of the fact that lakes and waterways should be maintained in a pristine condition with low to moderate levels of aquatic plants. In South Africa a large number of our estates and resorts employ sterile grass carp as a management tool to achieve this.

Being a responsible land-owner - Using sterile grass carp

Fish may not be stocked into dams and rivers without a permit. [No sterile grass carp allowed in SA rivers – see DWA Protocol]. Provincial Nature Conservation authorities do not allow fertile grass carp to be stocked into dams and irrigation canals, and require that sterile certified fish be used. This is because such fish, if they escape into nearby rivers, when dams overflow during the rainy season, cannot breed and cause environmental damage.

Grass Carp Application and Cost

Grass carp will grow at an average rate of 1.8 kg's per year from year two. Consuming up to their own body weight of weeds per day in summer, they can clear a dam of all vegetation within two to three seasons. The success is largely determined by choosing the correct stocking density in year one. As they are long lived, (12 years and more) they can maintain weed control for at least 12 to 15 years.

Sterile grass carp is also used as part of a preventative maintenance programme on South African irrigation schemes. In these Integrated Aquatic Vegetation Management Programmes for Irrigation Systems sterile grass carp is applied in conjunction with an organic herbicide and algaecide (Magnacide H Herbicide – L8655) to control aquatic vegetation. Sterile grass carp is used in the balancing dams and on-land irrigation dams, while Magnacide H Herbicide is applied in the flowing canals of irrigation systems. The combination of a biological and chemical approach provides excellent results. Water can be delivered on time throughout the system without any problems.

Considering the cost of stocking at between R7, 500 and R8, 000 per hectare, it is an investment worth looking at. With an expected lifespan of up to twelve years, cost per hectare per day is less than R2, for the twelve year period. The cost of chemicals for the same period could be 50 times that or more.

By stocking sterile grass carp in a responsible manner, you can maximize your use of your water resources and save money on irrigation costs.

For more information on sterile grass carp, you can visit www.grasscarp.co.za