A METHOD FOR THE DETERMINATION OF THE SUITABILITY OF COASTAL REGIONS FOR THE CONSTRUCTION OF BRACKISH WATER PONDS

by

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ABSTRACT

Outlines the characteristics required of sites for brackish water pond construction partially referring to the characteristics between the site and recorded tidal data. Specifies a minimum effective flooding depth of 40 cm.

Brackish water fishponds are principally located in strips of various width along low, level coasts with alluvial soils. Conditions for various ponds differ, however, widely. Only one row of ponds lies along the seashore and can obtain the water immediately from the sea, the other ones are situated at various distances from the sea. In general the altitude of the region increases with increasing distance from the sea, which has unfavourable consequences with regard to the water supply of the ponds and causes large differences in the costs of construction of the ponds.

It is a well known fact that in the past many brackish water fishponds have been constructed on sites that were not or only partly suitable for these purposes (Fig. 1). This may be attributed to the fact that people at that time had not a clear insight into the characteristics to which a pond must comply or the work necessary to fulfill these requirements, in connection with the available implements (Fig. 2 and 3). Apart from the costs of construction the suitability of a given site for the construction of a brackish water fishpond is governed by a number of factors:

1) Soil characteristics (soil type, fertility, structure, composition).

2) The water relations of the region (flooding by adjacent streams).

3) The presence of legal regulations (adat).

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4) The supply of fish fry (catching places, transport).

5) The sale of the cultivated fish (markets).

6) The economic situation of the local population.

Only when it has been ascertained that these factors are favourable the matter of costs of construction may be taken into consideration. These costs depend upon the technical measures that have to be carried out in order to make the pond comply to normal requirements based upon scientific data. In this respect can be mentioned the height of the dikes, the conditions of the pond bottom and the material required for the sluices. Generally speaking a pond requires firm dikes of a sufficient height, a well levelled pond bottom that allows a sufficient water height and a sluice of a solid construction.

The height of a dike should be at a minimum one meter above the highest normal high flood level. The width of the top must be equal to the height and the slopes should be made with a gradient that is adapted to the kind of soil used (Fig. 4). In general the excavation will supply enough soil for the construction of the dikes. Stumps and roots and other extraneous residues should be removed from the pond bottom, because the catch of fish is rendered difficult. The sluices can be made of concrete, brick or wood. The costs will decrease in this sequence.

The costs that must be incurred for these requirements depend upon (1) the amount of work and (2) the amount of materials that are necessary for the construction. It is quite logical that these expenses are calculated before starting the construction. They can only be calculated after a thorough investigation of the situation of the given locality.

The amount of work depends principally upon the amount of soil that has to be excavated. It should be borne in mind that every excavation of 10 cm on an area of 5 hectares amounts to a quantity of soil of 5000 m^3. This will have to be excavated in the majority of cases by manpower. This excavation of soil causes one of the major expenses in the construction of a pond and it will mainly depend upon the height of these costs, whether an economical exploitation will be possible or not.

The amount of soil that has to be excavated can only be calculated when the relation between the soil level at a particular site and the height of flood tides at that site is known. It may be stated that economic, planned exploitation of a pond is only possible when a water height of at least 40 cm can be permanently maintained. This will only be possible if the pond can easily be filled to that height and the water that disappears by seeping and evaporation can be replenished to this minimum height at adequate intervals. This means that flood tides must regularly attain a height of at least 40 cm above the prospective pond bottom.

It is a well known fact that the height of the flood tides shows

a 14 day periodicity during the year. Flood tide periodicity of important places along the coasts of several countries is generally well known (Fig. 5). This is often not the case with the regions between these places. Moreover even slight differences in soil elevation play an important part. This implies that the floods will have to be measured locally in the majority of cases. This is rather simple in cases where the locality is bordered by the sea. The situation is more difficult when the place is situated at a distance from the sea-shore. In such cases seawater must be supplied to a pond by a canal or a stream. The properties of these are partly responsible for the height of the floods at the prospective pond site. Preferably the water conduit should be straight, wide and deep, without obstacles, as for instance bamboo fishtraps. This implies that a canal is generally better than a stream. Moreover the sea water in a stream is often mixed too much with fresh water. Measurements can be carried out at a point where the pond site adjoins the water conduit. Simultaneously the altitude of the pond site should be measured for comparison with this point.

The length of the period of measurements depends on several factors. If the locality is not far from a port where flood tide heights during the year are known and if there are no confounding conditions, there might be a possibility of deduction, after a period of 2 or 3 months, for the rest of the year from the data of this port. This will be allowed only when the exact data show a close correlation. When this is not possible measurements should last one year.

The flood periodicity that has been found should be represented in a graph. It will be seen then that there are more and less favourable 14-day periods, but possibly at the same time for longer periods during the year. From this graph the period of the least favourable flood heights should be selected (Fig. 6). In this graph the soil level of the pond site must be included. After that it will be possible to determine the frequence and periodicity of flood tides which exceed the soil level by at least 40 cm. It is not possible to give a generally valid figure of the number of flood tides which are necessary for keeping the water level in a pond on a height of at least 40 cm. This number will differ for various ponds according to the particular local conditions with regard to seepage and evaporation of water and other losses. Seepage depends on the soil type, evaporation on the daily radiation of the sun and other losses can be caused for instance by certain methods of shrimp catching. It may be assumed that in certain cases the water in a pond must be replenished at least once in 10 days. Starting from this assumption it is possible to determine in the graph the flood height that is reached at least once in 10 days. It can be seen then whether and, if so, how frequently the present soil surface is washed by floods with a height of more than 40 cm. This may be not at all or only rarely. This is represented in figure 6. The level of the pond

bottom should be 40 cm below this level. This difference between the present soil surface and the latter level determines the amount of soil that has to be excavated and to a large extent the cost of construction.

In this discussion it has been assumed that the water can enter the pond unhampered. It must be taken into account, however, that this is in fact through a narrow sluice, which limits the flow of water. Moreover the amount of water is restricted by the general characteristics of the supply canal. It is advisable therefore to lower the pond bottom by another 10 or more cm, by which measure the number of adequate flood tides is increased.

Knowing the local wages the total cost of excavation can then be calculated. Addition of the expenses for materials for sluices etc. gives the total cost of construction.

There remains the question, whether it is possible to become more or less independent of flood tides by the use of pumping equipments. These might be valuable especially in those regions, where flood tides are relatively low or where long periods of drought are frequent and coincide with extended periods of low flood tides. This possibility may well exist but it remains questionable whether this will enlarge the possibilities of pond construction on higher levels on more inland locations or even decrease the cost of construction.

The question has a technical and an economical aspect in so far that equipment is necessary that is technically reliable also for salt water and is not expensive in price and use. In this respect it must be said here that use of engine equipment is to be preferred above wind mills, because the latter depend on the presence of wind and are therefore unreliable for daily use.

The pump should be used for two purposes:

1. filling of the pond at the beginning of the exploitation period;

2. to replenish the water that is lost continuously by evaporation, seepage or other cause. In these two cases widely different requirements are to be fulfilled. The pump, however, has to comply with both of them. This may be demonstrated with an example of a pond of 5 hectares. It is assumed that this pond has to be filled with water to a minimum height of 40 cm, whereas the water has to be lifted to a height of 2 m. Where a long period of pumping would decrease the exploitation period, it will be clear that filling of the pond should be carried out in a short time, e.g. in 48 hours of continuous pumping. In this case a 5 h.p. pump will satisfy the requirements. The use of fuel can be roughly estimated on 2 liters per hour. When pumping is only possible during high water tides, the period of pumping will increase to many days. It will be doubtful

if a pump of 6 h.p. would be efficient in such cases.

If it is assumed that the water losses per day amount to 0.5 cm the above mentioned 6 h.p. pump will be able to replenish this quantity in half an hour, which seems to be very satisfying.

The use of this pump during an exploitation period of the pond of 180 days will increase the expenses by 48 x 2 + 180 x 1 = 276 liters of fuel plus the deductions for depreciation. When long pipelines have to be used the costs will be proportionately higher.

The power of a pump must increase according to the height to which the water has to be lifted.

REFERENCES

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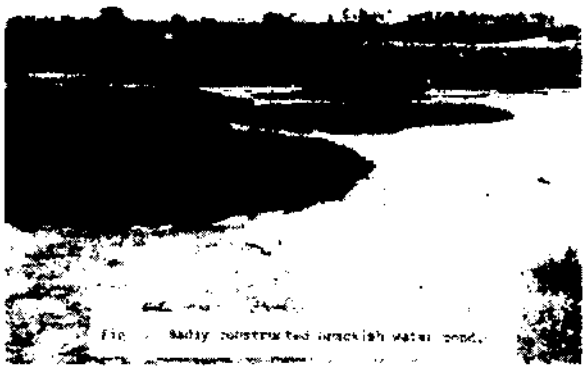

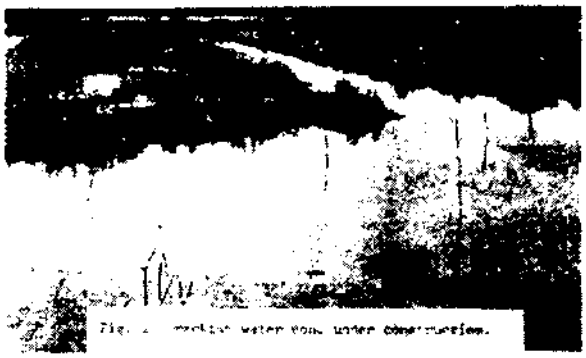

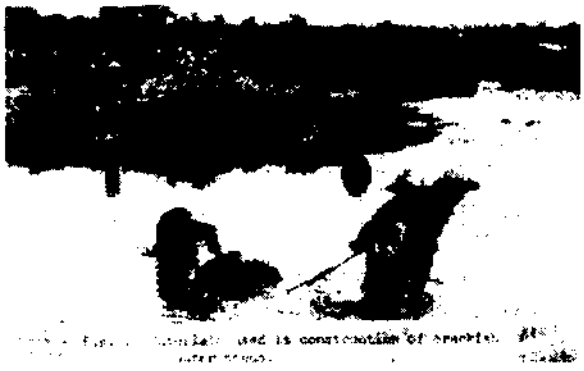

Fig. . Relation between floodlevel and level of the pond bottom

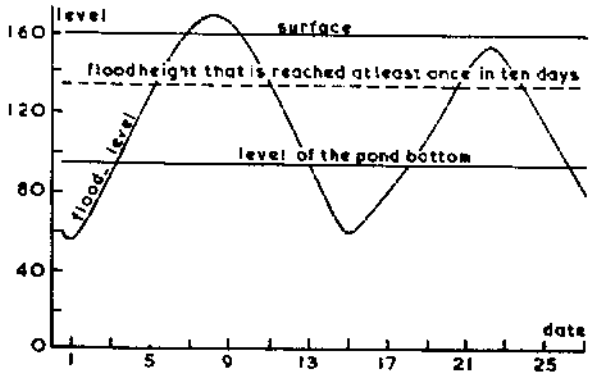

Fig. . Periodicity of flood tides during a year

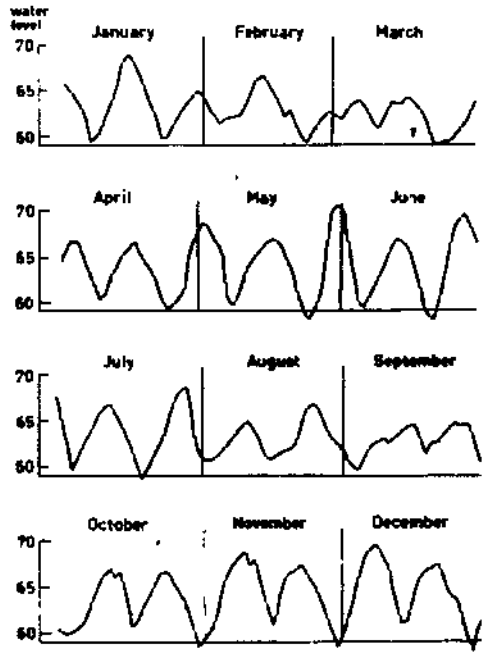

Figure 4 Scheme of a fish pond