Mahasagar-Bulletin of the National Institute of Oceanography, *13*(1), 1980, 53-60.

A SIMPLE INSTRUMENT FOR RECORDING TIDAL AND WATER LEVEL FLUCTUATIONS IN MANGROVE SWAMPS

ROZENN KERREST

Institut Francais, B. P. 33, Pondicherry–605 001 (India)

ABSTRACT

The fabrication and installation of an almost completely hand-made instrument is described in detail and as an example two weeks data are given. The records obtained are reliable. The instrument can be used in water-logged areas and mangrove swamps to calculate waterlogging duration.

INTRODUCTION

Actual data of tidal fluctuations (time and height) are very essential for any study dealing with mangrove or intertidal area. It enables us to fix suitable time for observation and collection. As waterlogging and salinity are the main well-known factors controlling the living forms in these areas, it is interesting to determine the duration of waterlogging at the site of observation.

Published theoretical tidal data are of little value in far reaches of wetland and mangrove because these are situated far from the open sea. Thus the tides in these regions are considerably delayed and have different range. This is the main reason for the development of this instrument, using simple materials, in Pichavaram mangrove (Tamil Nadu, India).

DESCRIPTION OF THE INSTRUMENT

The purpose of this instrument is to register on a recording cylinder the movement of a cork floating in water (Figs. 3, 4 and 5).

The cork F, kept floating inside a pipe, is attached to a long mobile arm E which is connected to a recording part ABCD (Fig. 3). These two connections are made by an unextendable thread.

The reducing system is a thin mobile stick with the proportion of the arms as

$$\frac{x}{y} = \frac{\text{Maximum width on the recording paper } e.g.\ 10\text{ cm}}{\text{Maximum amplitude of the water } e.g.\ 120\text{ cm}}$$

With this reducing system it does not seem possible to record a range of tide exceeding 150 cm as it would take too much space.

The recording system (Fig. 2) is composed of two equal arms moving around a low inertia axis C. One arm is rigid, loaded at the end with more than 100 g of lead to balance the reducing system's weight and allow the cork to come back. The other arm holds the head of a sketch pen which rests on the cylinder.

Fig. 1. Tidal gauge at the bank of the channel.

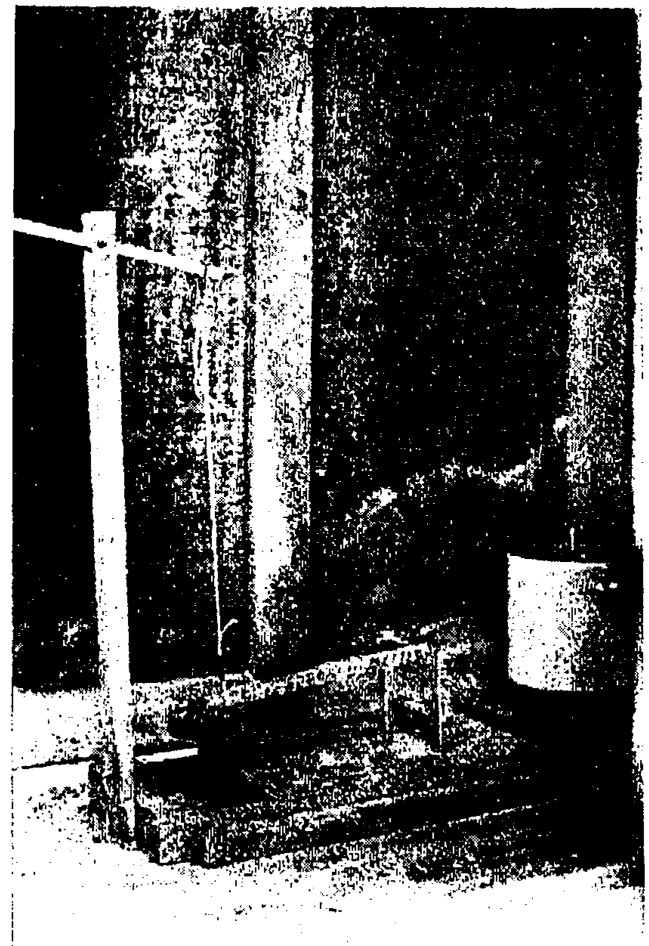


Fig. 2. Recording system of the tidal gauge.

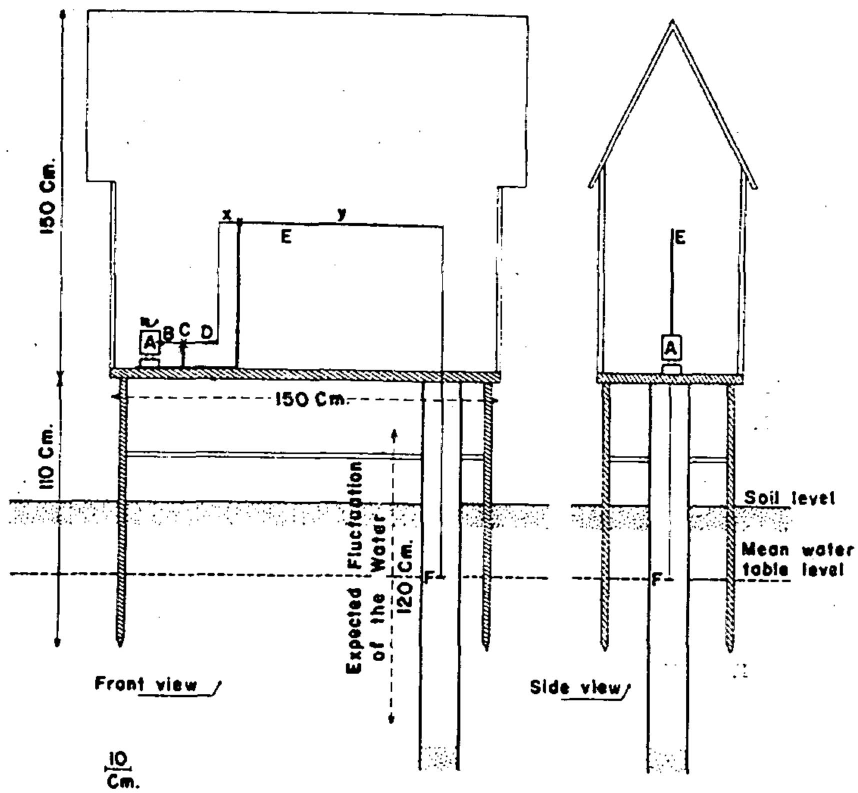


Fig. 3. Plan of the water table gauge.

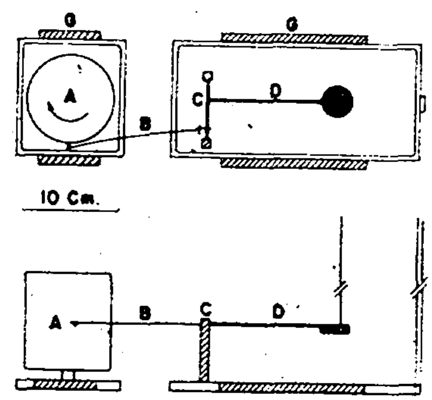
The whole instrument is fixed on a table, with a hole for the pipe, and is protected from the weather and human disturbances by a small 'house' which has a door carefully locked (Fig. 1).

The tidal gauge (Figs. 1 and 3) has been installed on a steep bank of a channel. At the soil level holes are made in the pipe to allow free movement of tidal water. For the water–table gauge which is kept inland, it is not suitable to make holes in the pipe since it is the level of the water–table inside the soil which we intend to measure (even if actually this water comes above the soil level during floods).

(*a*) *Dimensions:*

(*i*) diameter of the tube: wide enough so that the thread can move freely in it, taking into account the circular movement of the wooden arm E,

(*ii*) height of the reducing system E: half of the maximum fluctuation of the water.



A. Recording cylinder
B. Arm writing head
C. Axis maintained between 2 sharp steel conical pieces
D. Rigid arm with loaded head
E. Reducing system
F. Cork used for fishing-ϕ 5 cm, thickness 2 cm
G. Wooden pieces for fixation

Fig. 4. Plan of the recording part (Top and side views).

(b) *Material*:

(i) tube: poly-vinyl-chloride (PVC) pipe,

(ii) thread: unextendable plaited nylon thread, which is not damaged by wear and tear,

(iii) reducing part: thin teak stick,

(iv) recording part: specially devised for meteorological recording instrument (Richard-Pekly, 116, Quai de Bezons, 95102-Argenteuil, FRANCE). It is the only part which has not been made in the laboratory or by some local artisan. The recording paper is used for recording relative humidity (graduation 0–100),

(v) support and protective part: table made of durable timber and protective 'house' built with mango-planks, and the roof covered with painted tin sheets.

(c) *Approximate cost:*

	Rs.
Recording system	ca. 1000
Timber for the table	340
Mango planks for the house	130
Labour charge	90
PVC pipe	110

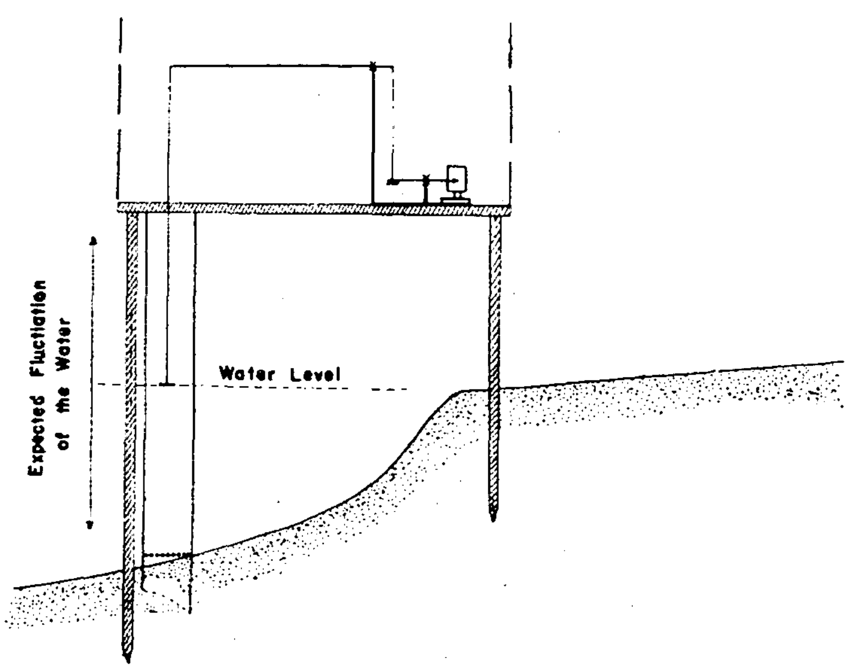


Fig. 5. Plan of the tidal gauge.

(d) Installation of the instrument in the field:

Holes are dug for the legs of the table and for the pipe and the whole system is sunk slowly by hammering, keeping the table horizontal and the tube vertical. Then the protective house is fixed over the table, using L clamps, and the recording system is set up inside.

Two weeks data (as an example)

Tidal gauge data (Fig. 6a) show spring tide during the first week with sharp maximum and minimum, rising for 5 hours and decreasing for 7 hours and neap tide during the second week with reduced daily amplitude. It can be noted that the lowest of the low tides (during the days often chosen for soil collection) take place during the neap tide but not during the spring tide as is the case in the coastal area. These are common features noticed in tides of estuaries (Guilcher, 1965).

Water-table gauge data (Fig. 6b) during the same period show that from the second day of the first week the area gets flooded, the tide comes twice daily, rising in 2 hours and decreasing in 10 hours. A part of the water remains stagnant. During the second week, as the tide does not reach the place, the water level decreases slowly. The area dries off (from 26th August), the water-table falls down step by step (as shown on 26th, 27th, 28th August) probably under the influence of the general tidal movement (Viellefon, 1977).

A comparison between these two graphs shows a delay of 2 hours in the high tide and a much smaller range inland, and that the high tide has to pass beyond the tidal gauge graduation level of 80 to flood the inland area.

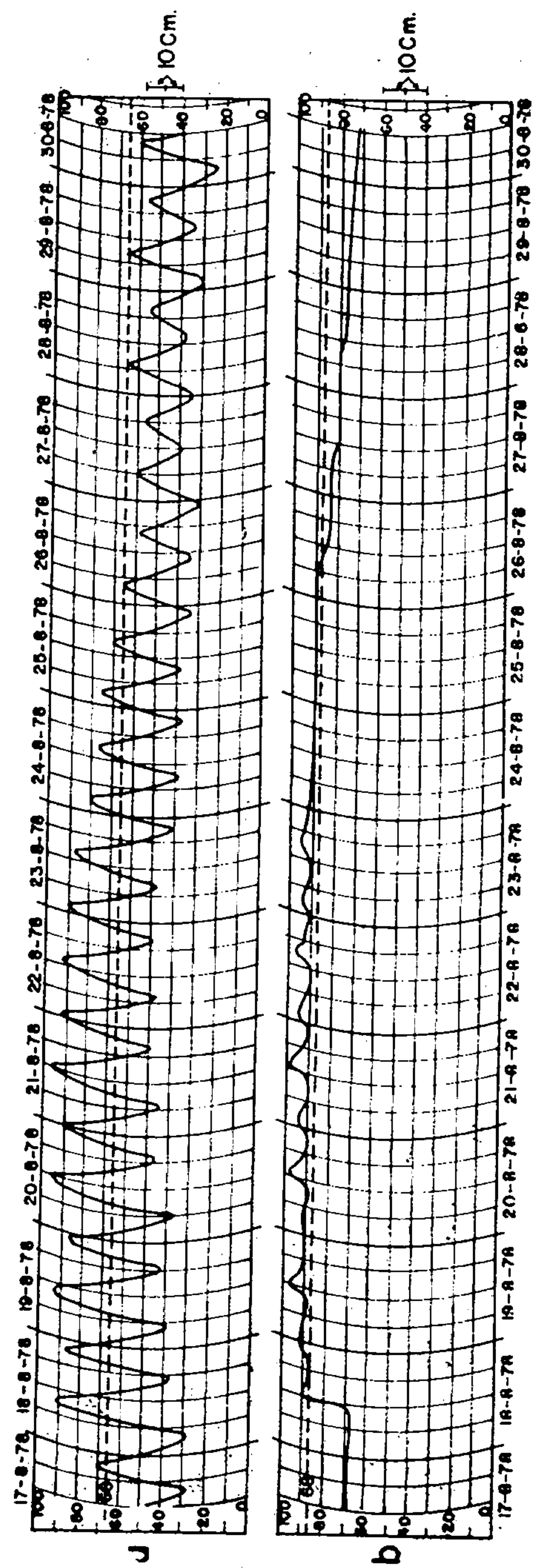


Fig. 6. Example of recorded data (a) Tidal gauge (66=Level of the Rhizophora zone), (b) Water table gauge (88=Soil surface level of the gauge site).

Standardization of the instrument

It is not desirable to use a theoretical range to know the equivalent between the recording paper's graduation and the actual height of the water. Therefore, the instrument needs experimental standardization which is to be carried out as long as the instrument is in operation.

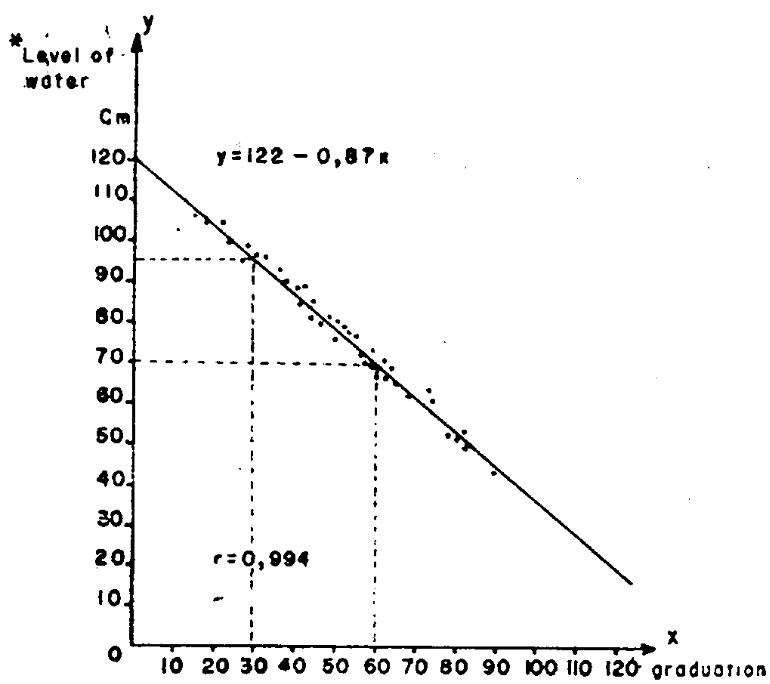
Every week, the observed level is marked on the recording paper by turning the cylinder. At the same time the level of the water from a reference point is measured. The regression line (Fig. 7) obtained for six months data shows the steadiness of the recording (correlation coefficient: 0·994). Thus from the graduation the actual value can be obtained. For example, the graduation 60 is equivalent to 70 cm of water from the reference point and range of 30 graduation corresponds to 26 cm of water.

Application of the tidal gauge for the measurement of waterlogging in different zones

Mangrove vegetation grows in successive belts of different plant communities (Fig. 8). To study the ecological features of each community it is necessary to know the duration of waterlogging in each zone, which is the main factor controlling the vegetation (Watson, 1928).

Firstly, the microtopography of the area should be known, along a cross section and this should be correlated with the tidal gauge readings and then the duration of waterlogging in each zone should be calculated as given below:

(a) Study of microtopography along a cross section: This is done in a very simple way—a thread is tied between two poles horizontally and the distance between the soil surface and the thread is measured. However, for such measurements the following points should be noted:



* The level of the water if taken from the lower surface of the gauge-table to the water surface.

Fig. 7. Standardization of the tidal gauge.

Check the thread between the poles with an air–level. Keep the poles close enough so that the sagging caused by the weight of the thread is negligible. Avoid movement of the pole in the soft soil while tightening the thread. Measurements should be made at closer intervals in the case of steeper slopes or when the surface of the soil is irregular. If the vegetation is too dense, the thread has to be put up or down, from a known distance which will be accounted for in the measurements.

A common feature observed at Pichavaram mangrove was an elevated border with mixed vegetation and a central lower area, partly barren and partly covered with the species *Avicennia marina* Vierh. (Fig. 8). Maximum range in the topography was only 30 cm.

(b) *Correlation between microtopography and tidal gauge:* From the cluster of mangroves, one tree is marked and this is used as a reference for all the points of the cross section and for measuring the height of the water. As it is not possible to get simultaneously the level of the water at the reference tree and on the tidal gauge, only the maximum and minimum values will have to be taken. Both high or low tide levels are watched and marked.

Fig. 9 shows a very high correlation (r=0·997) and a regression line very similar to the previous one (Fig. 7). The tidal range is equivalent at both the places. However, it is only by chance that the reference marks are at the same level. Since the level of the reference mark in relation to the microtopography is also known, each point of the cross section can be correlated to its corresponding level of the tidal gauge. Then by drawing a line on the recording paper at that level, the exact duration of waterlogging is obtained. As an example, if the level of the *Rhizophora* zone from the reference mark on the tree is 60 to 65 cm, the average will correspond to 66 graduation on the recording paper (Fig. 9).

In Fig. 6, from the intersection of the line 66 and the curve, we can read that the zone has been flooded during a two hours period in the afternoon on 17–8–78, a six

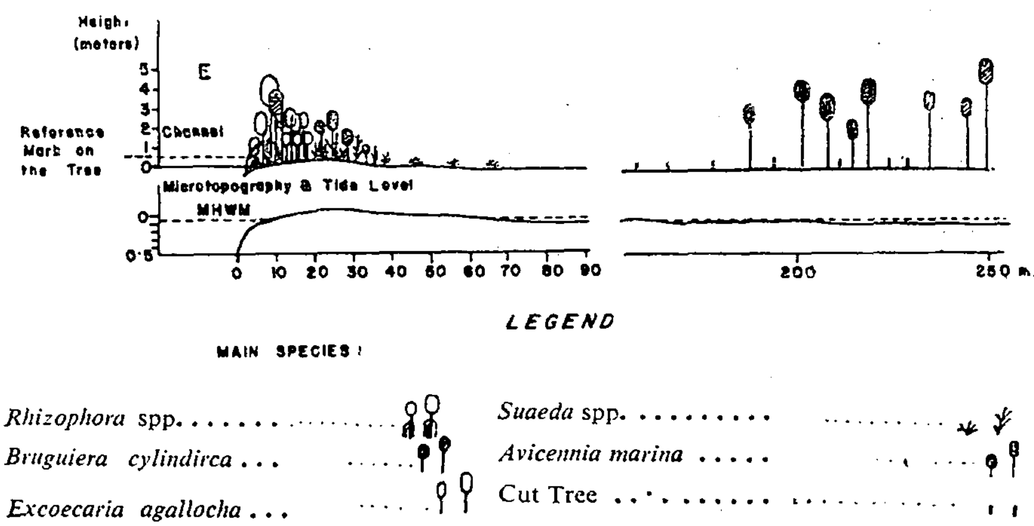


Fig. 8. Cross section through Pichavaram mangroves.

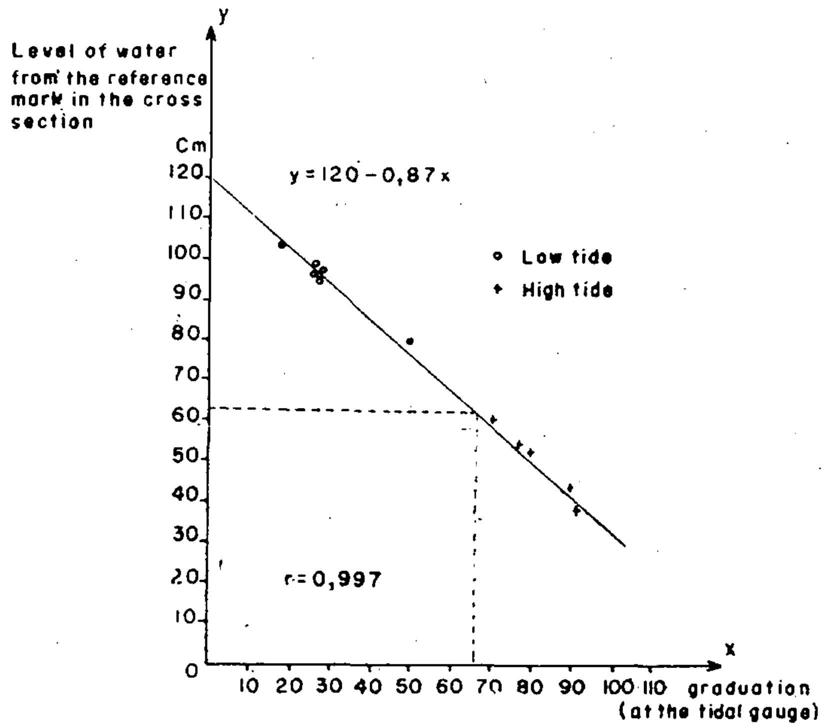


Fig. 9. Correlation between water level at the cross section and at the tidal gauge.

hours period in the morning of 18-8-78 and so on and 92 hours for an entire period of two weeks.

From this method, the duration of waterlogging (per month, per year) of all the zones bordering the channel can be easily determined. The same method can be used for the inland areas in relation to a nearby water-table gauge.

CONCLUSION

The instrument described here is useful for the studies on mangrove ecology. It is simple and easy to build. Except for the recording part, which can be obtained from any indigenous temperature or humidity recording instrument, everything else can be fabricated in the laboratory.

If the standardization is carefully done, both tidal and water-table fluctuations can be obtained with very precise details. In the same way, the duration of waterlogging in the mangrove zones can be estimated accurately if proper precautions are taken.

ACKNOWLEDGEMENTS

I am grateful to Prof. P. Legris, Director of the French Institute for providing full facilities and to all my colleagues for their constant encouragement. I would also like to thank Messrs. P. Arumugham, K. Balasubramaniam and G. Orukaiman for their expert technical assistance.

REFERENCES

Guilcher, A., 1965. *Precis d'hydrologie marine et continentale.* Masson-Paris. 389 pp.

Vieilefon, J., 1977. Les sols des mangroves et des tannes de Basse Casamance (Sénégal). *Memoires O. R. S. T. O. M.*, 83: 1-291.

Watson, J. G., 1928. Mangrove forests of the Malay Peninsula *Malayan Forest. Rec.* No. 6. Fraser and Neave, Ltd., Singapore, 275 pp.