THE EAST AFRICAN WEATHER REPORT

W.T.W. MORGAN AND L. W. HANNA

The East African Weather Report has been issued weekly since June 1966 to cover conditions from Wednesday to Wednesday. At present the reports consist of daily pressure charts (at 1200 hours G.M.T.), a table of weekly rainfall and a map showing the week's rain at 106 stations, together with a page of comment on the weather of the week. These charts provide the geographer with an opportunity to study conditions only a few days after they have been experienced and so are valuable teaching aids. A short statement entitled *Notes for users* has been prepared but this present note supplements this. It may also be helpful to discuss the relevance of these charts to the geographer and to introduce students to modern concepts of tropical meteorology of especial significance to East Africa.

In the past there has been a tendency to explain the climate of East Africa by reference to convectional rainfall, to the "Inter-tropical Front" or to air masses. Simple thermal convection is inadequate as an explanation of rainfall in East Africa as it does not explain why convection does not take place during the dry season. Also, convectional rain tends to occur in the afternoons whereas in many parts of East Africa the maximum rainfall is at other times, including even the middle of the night, as in southern Uganda. Explanations based on air masses are also unsatisfactory as is shown during the common conditions of moist air and a cloud-patterned sky but without the vertical development of clouds necessary to produce rain. The concept of the "Inter-tropical Front" is also misleading, particularly in East Africa where differences in adjacent air masses are often very small and the line between them indeterminate and insignificant.

Provided that there is some moisture in the atmosphere the production of rain requires an upward movement of air. This will cool the rising air to the point of saturation, lead to the formation of clouds, and, after further ascent, to the probability of rain. In the reverse manner, descending air will become warmer, thereby reducing its relative humidity and bringing about dry conditions. Upward movement may be initiated by either thermal or dynamic causes. A thermal cause is the heating of the lower layers of the atmosphere which results in thermal uplift or convection. A cause of dynamic uplift is the obstruction of an airflow by mountains which results in the common phenomena of relief or orographic rain and rain shadows. A third cause of uplift is by *convergence*. Studies made by the E.A. Meteorological Department show that in East Africa *convergence* is the most important single factor determining variations in rainfall. This factor is emphasised in the East African Weather Reports.

Convergence occurs when more air flows into an area than leaves it on the same level. When this happens at low levels some of the air can only escape by rising. This may be caused by *confluence* in which the direction of air flows is towards each other such as occurs when northeast and southeast winds meet. It may also result when the airflow is slowed down by friction or by the presence of high pressure ahead, so that air enters an area faster than it is leaving. This is known as *linear convergence*. An upward movement of air will only occur if the convergence is at a low level. If the convergence is at a high level in the

atmosphere the air will escape downwards, thus creating exactly opposite conditions. Ascending air may be brought about *either* by low level convergence *or* by high level divergence. A full calculation of vertical movement in the atmosphere thus involves a knowledge of what happens at various levels and upon wind speeds and wind direction as well as the temperature and humidity of the air. Even if all this information is available, and often much of it is not, it could not be provided in a weekly Weather Report.

The pressure conditions can only be shown for one level in the atmosphere and it has been necessary to select that which is most frequently indicative of the causes of the weather. This has been accomplished in the Weather Reports by plotting the height above sea level at which the atmospheric pressure is 850 mb. The contours in metres (or tens of metres) show the level of this pressure surface. This is high enough above the ground to remove most of the effect of topography and friction, though it must be noted that the land surface of the Kenya highlands reaches to the 700 mb. level. However, since pressure and windflow is only shown at this one level where there may be no convergence, widespread rain can result from uplift if strong divergence at higher levels takes place, say at the 300 mb. level. Such occurrences are explained in the notes accompanying each Weather Report.

The synoptic conditions which produce convergence or divergence in the atmosphere are thus of the greatest importance. They have been studied in East Africa and models formulated as an aid to forecasting. These are illustrated and described in detail by Johnston and Mörth and a more simplified account is given in *The climate of Africa* by B. W. Thompson. These models can be used effectively to interpret the conditions portrayed on the daily charts and their effects on the patterns of rainfall may be demonstrated. The simplest forms can be summarised as follows:—

(i) *The Equatorial Duct* occurs when two areas of high pressure lie over Africa, one to the north of the equator and another to the south. The easterlies are able to flow along the duct between the highs, converging as they enter and bringing cloudy rainy weather at the entrance. The persistence of these disturbances depends on the relative position of the highs, for a narrow duct will produce stronger and more persistent easterlies. At the exit from the duct, divergence will occur and drier weather will be more likely.

(ii) *The Drift* occurs if a high on one side of the equator lies opposite to a low on the other side. Air flows from the high to the low across the equator, diverging from the high and converging as it approaches the low. This occurs frequently during the solstices. For example, during the northern summer, low pressure is common north of the equator, while a high persists to the south. Thus a zone of convergence and the resulting rainfall lies to the north of the equator. At the equator the airflow may be regarded as a "drift" being neither strongly convergent or divergent.

(iii) *The Bridge* is produced by a low pressure area on either side of the equator which induces a westerly current of air between the lows. For dynamic reasons westerly air tends to be unstable with uplift carrying moisture to high levels. This condition of widespread rain is less common in East Africa.

These are simple forms and variations frequently occur. It would be wrong to attempt to find a cause for weather patterns from the 850 mb. chart alone, but it goes along way to explain the complex conditions in the inter-tropical zone. While an 'Inter-tropical trough' exists, moving north and south with the seasons, these models show that simple convective rainfall following the overhead sun

and giving a seasonal shifting rainbelt is an over simplification and does nothing to explain the weekly rainfall records. Reference to the contour charts and the rainfall distribution provides a more accurate picture of seasonal patterns.

Meteorological readings are taken at many schools and colleges throughout East Africa. The phenomena recorded at each station can be seen in relation to East African weather as a whole and the influence of local topographical effects can be more easily evaluated. Meteorological readings taken, for their own sake, by students of geography can now have a greater justification educationally. Th relationship with much of the rest of Africa and the Indian Ocean can be clearly seen on the charts, while the expanse of the maps suggests the close link which exists between conditions in the inter-tropical zone and atmospheric behaviour in temperate latitudes. Thus the detail of the local environment can be expanded to the continental and the world view.

* * * * * *

The charts and comment are kindly made available by the East African Meteorological Department and the costs of reproduction and distribution are met by a grant from the East African Teaching Materials fund of the University of East Africa. The editor is Professor W. T. W. Morgan of the Department of Geography, the University College, Nairobi.

REFERENCES

Thompson, B. W. *The climate of Africa*: Nairobi: O.U.P. 1965, East African price 150 sh.

Thompson, B. W. and Sansom, H. W. Climate, in Morgan, W. T. W. (ed.) *Nairobi: city and region,* Nairobi O.U.P., East Afrian price 35 sh.

Trewartha G. T. *The earth's problem climates.* Madison: University of Wisconsin Press, 1961.

Johnston, D. H. and Mörth, H. T. Some trans-equatorial contour analyses, E.A. Met. Dept., Memoir Vol. III, No. 8, 1961, East African price 5sh.

Johnston, D. H. and Mörth, H. T. Forecasting research in East Africa: E.A. Met. Dept., Memoir Vol. III, No. 9, 1961, East African price 8 sh.

(Publications of the E.A. Met. Dept., are obtainable from the E.S.A. Bookshop, P.O. Box 30167, Nairobi, The Uganda Bookshop P.O. Box 145, Kampala, or The Dar es Salaam Bookshop, P.O. Box 9030, Dar es Salaam).