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The Role of ICTs in Quantifying the Severity and Duration of Climatic Variations – Kenya's Case

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Cape Town, South Africa
12–14 December 2011

Motivation

- Kenya, like many countries in the SSA, is frequently affected by natural disaster triggered by climatic variations; especially droughts
- The Government of Kenya is putting initiatives in place; but still lacks effective early warning system
- Traditional seasons that farmers were used are changing

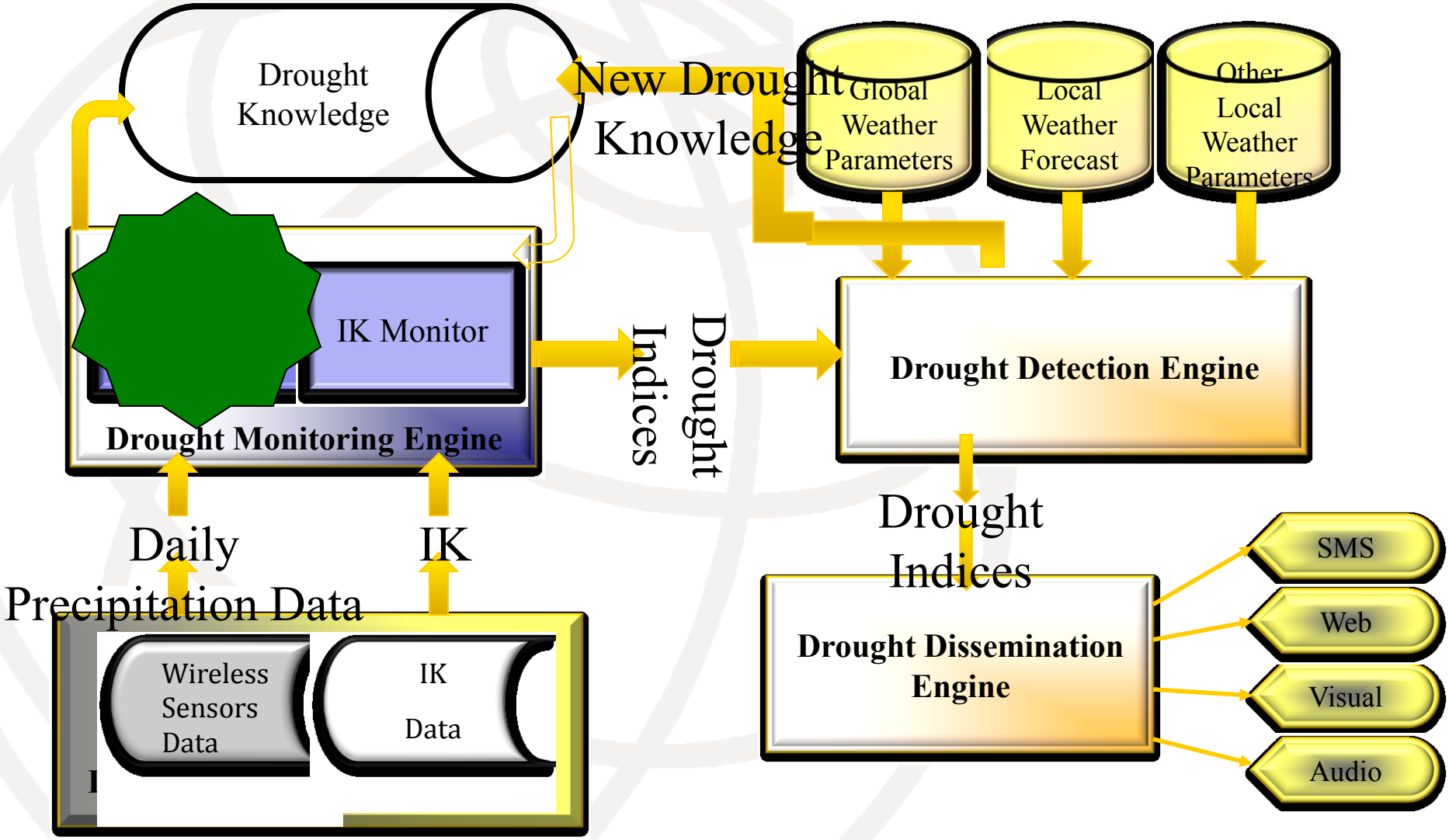
The Gaps

- The Seasonal Climate Forecasts (SCFs) are based on expensive sparse weather stations.
  - Kenya – 27 with 21,500km^2;
  - Professional Weather Stations costs between 200K to 6M ZAR!
- Forecasts are not user-centred
- Dissemination channels are not effective

Overall Objective

- This paper is part of a larger project whose objective is develop 'homegrown' Early Warning System (EWS) for climatic variations. The system makes uses of Intelligent Agents to bring together; IK, scientific weather forecasts, Wireless Sensor Networks (WSNs) and mobile phones

Integration Framework



Working Definitions

- **Climatic Variations** – departures from seasonal rhythms of climate; may lead to droughts and floods
- **Drought**;
  - **Conceptual Definitions**
  - **Operational Definitions**
  - The common element in the definitions is "precipitation deficiency" whose level further determine **drought types**: *meteorological*, *hydrological, ground water*, *agricultural and socio-economic*
  - ***Drought indices:*** intensity, duration, severity and spatial extent; time scales. Examples; EDI, SPI, PDSI
  -

Why Effective Drought Index

- Byun and Wilhite came up with EDI in 1999 to address some weaknesses of other indices.
- Advantages of EDI:
  - It calculates daily drought severity
  - Rapid detection and precise measurement of short term drought
  - Indicates the current level of water resources
  - It is able to diagnose prolonged droughts that continue for several years; it calculates the total precipitation

Overview

- The Kenya Meteorological Department (KMD) in charged with weather forecasting, among other services
- Relevant weather data is collected at the Climatological and Agrometeorological Sections of KDM and used for forecasts such as:
  - Daily, 4-Day, 7-Day, monthly and seasonal

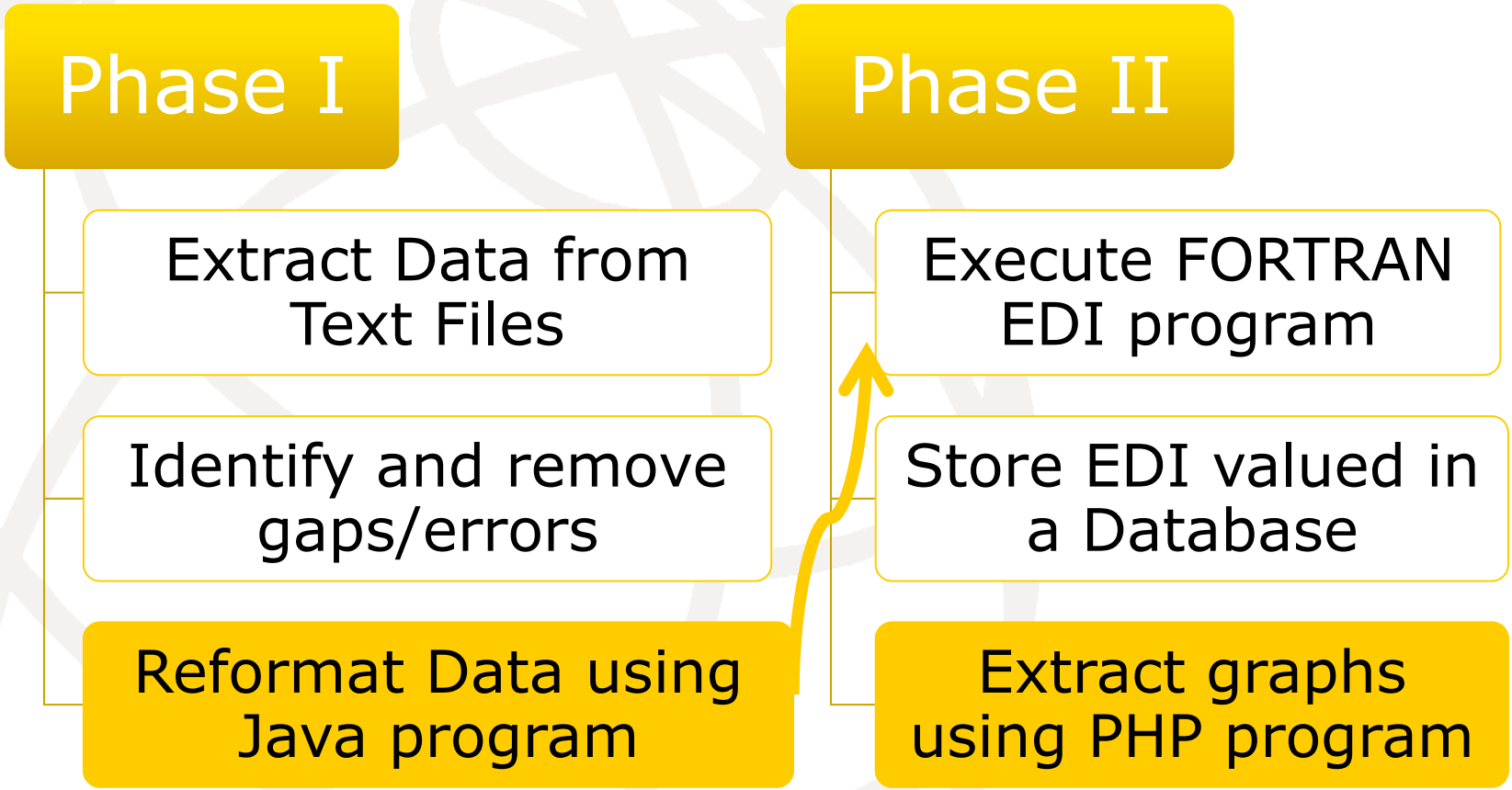
Quantifying Droughts/Floods

- **Data Used:**
  - Daily precipitation data for years 1979 to 2009 for Dagoretti, Embu and Makindu

Name	Dagoretti	Embu	Makindu
WMO#	63741	63720	63766
ICAO	HKNC	HKEM	HKMU
Year Opened	1954	1975	1904
Latitude	01 18S	00 30S	2 17S
Longitude	36 45E	37 27E	37 50E

Quantifying Droughts/Floods

- **Methodology:**



Quantifying Droughts/Floods

- **Daily EDI Computation:**
  - Input File Format

Year	Date	Month	Total Precipitation
1979	1	1	1.5
1979	2	1	0.5
2009	31	12	50.10

  - Output File Format

Date	Total Precipitation	AWRI	EDI
28/03/1980	19.0	96.1	-0.96
23/12/2009	5.5	162.7	-0.83

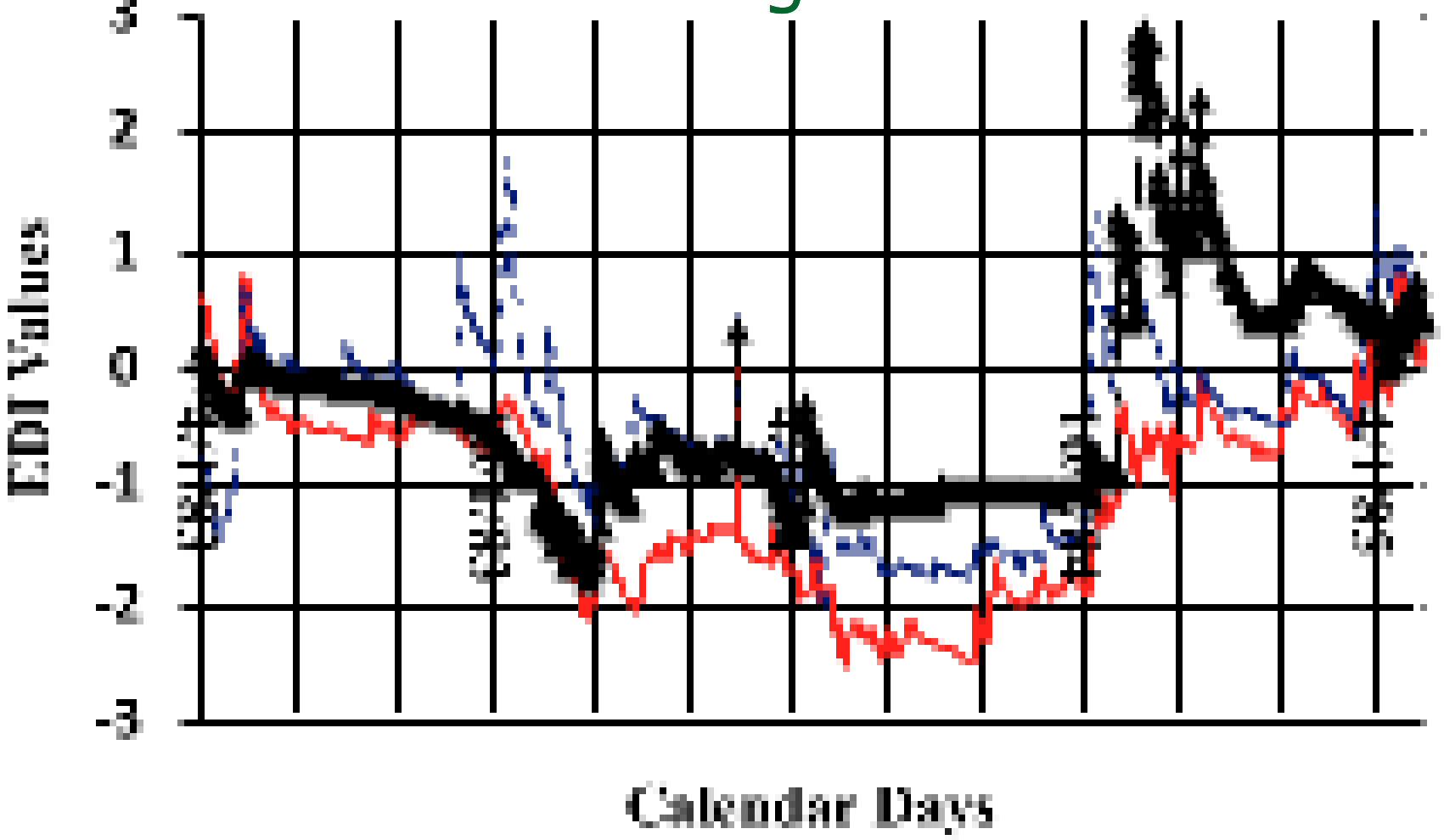
Quantifying Droughts/Floods

- **EDI Classification used:**
  - Input File Format

Class	EDI Value
Extreme Flood	EDI>2
Severe Flood	1.5>EDI<1.99
Moderate Flood	1>EDI<1.49
Wet-Near Normal	0.01<EDI>0.99
Drought Near Normal	-0.99<EDI>0.00
Moderate Drought	-1<EDI>-1.49
Severe Drought	-1.5<EDI>-1.99
Extreme Drought	EDI<-2

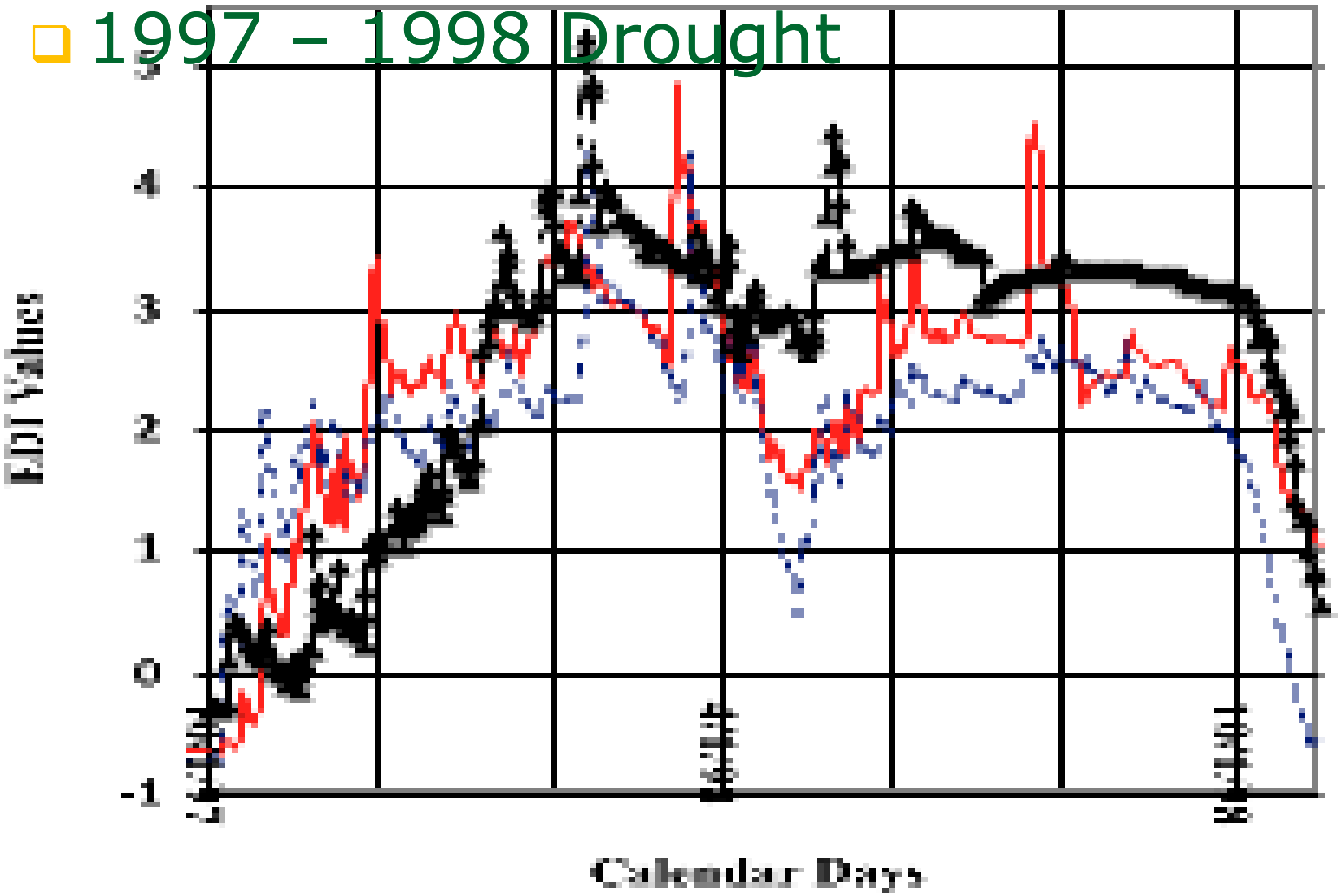
Results

- 1983 – 1985 Drought



Results

- 1997 – 1998 Drought



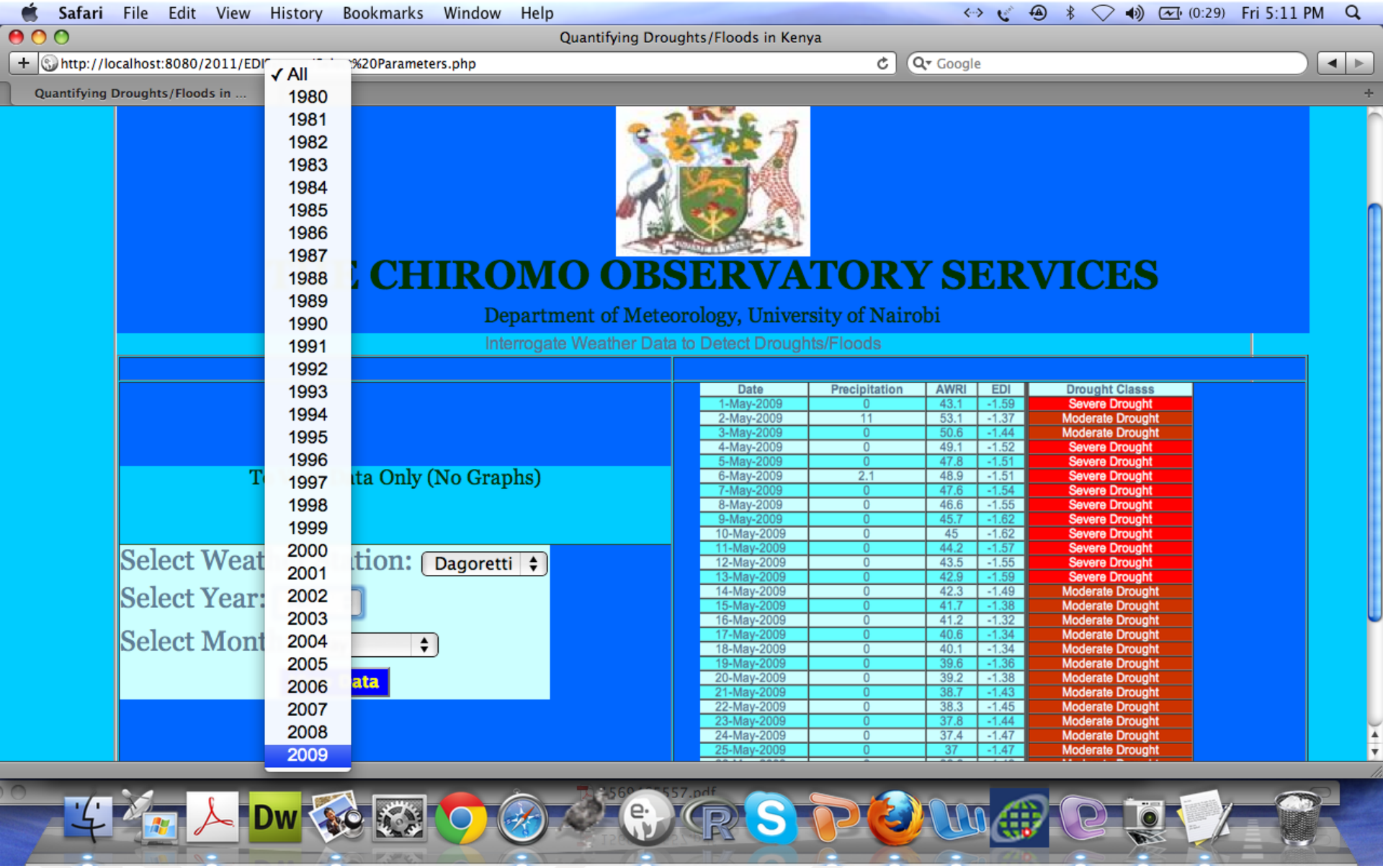
Results

- Discussion
  - Drought was experienced in all the three regions with Dagoretti leading with an average of -1.06 (compared to -0.49 and -0.33 for Embu and Makindu respectively)
  - Drought was worse in the ***November 1983 to November 1984*** period
  - The graphs for Dagoretti and Embu have similar patterns
  - The October-November-December 1997 torrential rains triggered the floods. The March-April-May 1998 rains later worsened this

Web Based Decision Support System

- **System Overview**
  - Daily precipitation, computed EDI/AWRI were stored in a MYSQL Database and manipulated using PHP. The latter was used to automate the EDI classification computation
  - **Jpgraph** software was used to draw charts

Home Page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Department of Meteorology, University of Nairobi
Interrogate Weather Data to Detect Droughts/Floods
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Dagoretti
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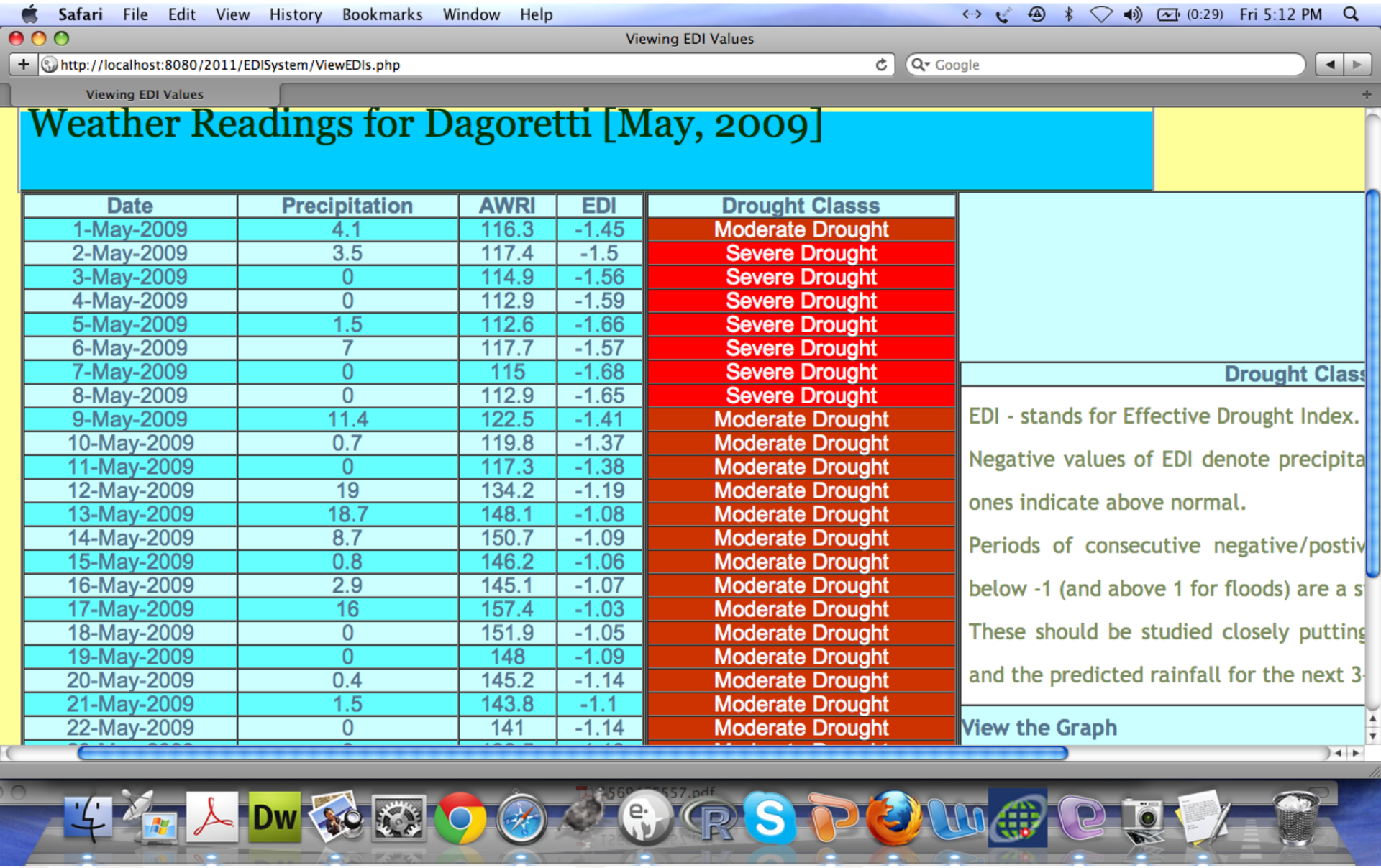
Date | Precipitation | AWRI | EDI | Drought Classs
1-May-2009 | 0 | 43.1 | -1.59 | Severe Drought
2-May-2009 | 11 | 53.1 | -1.37 | Moderate Drought
3-May-2009 | 0 | 50.6 | -1.44 | Moderate Drought
4-May-2009 | 0 | 49.1 | -1.52 | Severe Drought
5-May-2009 | 0 | 47.8 | -1.51 | Severe Drought
6-May-2009 | 2.1 | 48.9 | -1.51 | Severe Drought
7-May-2009 | 0 | 47.6 | -1.54 | Severe Drought
8-May-2009 | 0 | 46.6 | -1.55 | Severe Drought
9-May-2009 | 0 | 45.7 | -1.62 | Severe Drought
10-May-2009 | 0 | 45 | -1.62 | Severe Drought
11-May-2009 | 0 | 44.2 | -1.57 | Severe Drought
12-May-2009 | 0 | 43.5 | -1.55 | Severe Drought
13-May-2009 | 0 | 42.9 | -1.59 | Severe Drought
14-May-2009 | 0 | 42.3 | -1.49 | Moderate Drought
15-May-2009 | 0 | 41.7 | -1.38 | Moderate Drought
16-May-2009 | 0 | 41.2 | -1.32 | Moderate Drought
17-May-2009 | 0 | 40.6 | -1.34 | Moderate Drought
18-May-2009 | 0 | 40.1 | -1.34 | Moderate Drought
19-May-2009 | 0 | 39.6 | -1.36 | Moderate Drought
20-May-2009 | 0 | 39.2 | -1.38 | Moderate Drought
21-May-2009 | 0 | 38.7 | -1.43 | Moderate Drought
22-May-2009 | 0 | 38.3 | -1.45 | Moderate Drought
23-May-2009 | 0 | 37.8 | -1.44 | Moderate Drought
24-May-2009 | 0 | 37.4 | -1.47 | Moderate Drought
25-May-2009 | 0 | 37 | -1.47 | Moderate Drought

Data Views – 1 Month, 1 Station, 1 year



Data Views – Multiple years/ Months

22-Jun-1984	1.5	107.6	-1.68	Severe Drought
23-Jun-1984	0	106.2	-1.7	Severe Drought
24-Jun-1984	0.2	105.2	-1.72	Severe Drought
25-Jun-1984	0	104	-1.74	Severe Drought
26-Jun-1984	0	102.9	-1.72	Severe Drought
27-Jun-1984	0	101.9	-1.74	Severe Drought
28-Jun-1984	0	100.9	-1.76	Severe Drought
29-Jun-1984	0	99.9	-1.77	Severe Drought
30-Jun-1984	1.5	100.4	-1.74	Severe Drought
1-Jul-1984	7.1	106.3	-1.63	Severe Drought
2-Jul-1984	0	104.1	-1.68	Severe Drought
3-Jul-1984	0	102.6	-1.69	Severe Drought
4-Jul-1984	1.3	102.6	-1.68	Severe Drought
5-Jul-1984	0	101.1	-1.7	Severe Drought
6-Jul-1984	0	99.9	-1.68	Severe Drought
7-Jul-1984	0	98.7	-1.69	Severe Drought
8-Jul-1984	0	97.6	-1.7	Severe Drought
9-Jul-1984	0	96.6	-1.71	Severe Drought
10-Jul-1984	0	95.6	-1.72	Severe Drought
11-Jul-1984	0.3	94.9	-1.71	Severe Drought
12-Jul-1984	1.6	95.4	-1.71	Severe Drought
13-Jul-1984	0.3	94.5	-1.71	Severe Drought
14-Jul-1984	1.4	94.8	-1.71	Severe Drought
15-Jul-1984	0.3	93.9	-1.71	Severe Drought
16-Jul-1984	0	92.7	-1.72	Severe Drought
17-Jul-1984	0	91.7	-1.74	Severe Drought
18-Jul-1984	0.3	91	-1.75	Severe Drought
19-Jul-1984	1.6	91.6	-1.74	Severe Drought
20-Jul-1984	0	90.4	-1.77	Severe Drought
21-Jul-1984	1.8	91.1	-1.76	Severe Drought
22-Jul-1984	3.9	93.8	-1.69	Severe Drought
23-Jul-1984	2.8	94.9	-1.65	Severe Drought
24-Jul-1984	1.2	94.4	-1.65	Severe Drought
25-Jul-1984	1.3	94.1	-1.62	Severe Drought
26-Jul-1984	0.3	92.9	-1.64	Severe Drought
27-Jul-1984	5.7	97.2	-1.56	Severe Drought
28-Jul-1984	3.3	98.5	-1.52	Severe Drought

Drought Class Graphs

EDI - stands for Effective Drought Index.

Negative values of EDI denote precipitation is below n

ones indicate above normal.

Periods of consecutive negative/postive values; espe

below -1 (and above 1 for floods) are a sign of drought.

These should be studied closely putting in mind the s

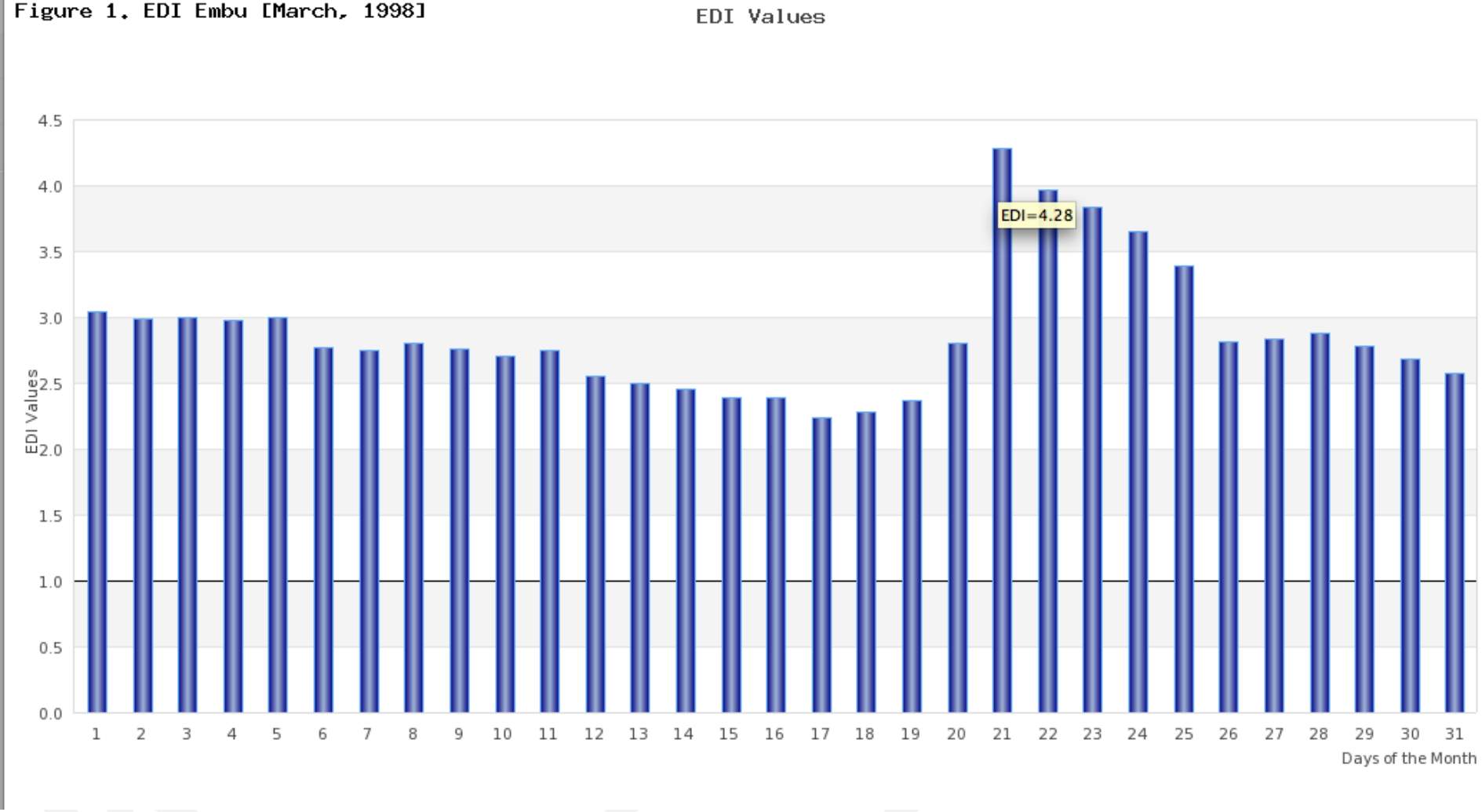
and the predicted rainfall for the next 3-7 days

View the Graph

Click Here

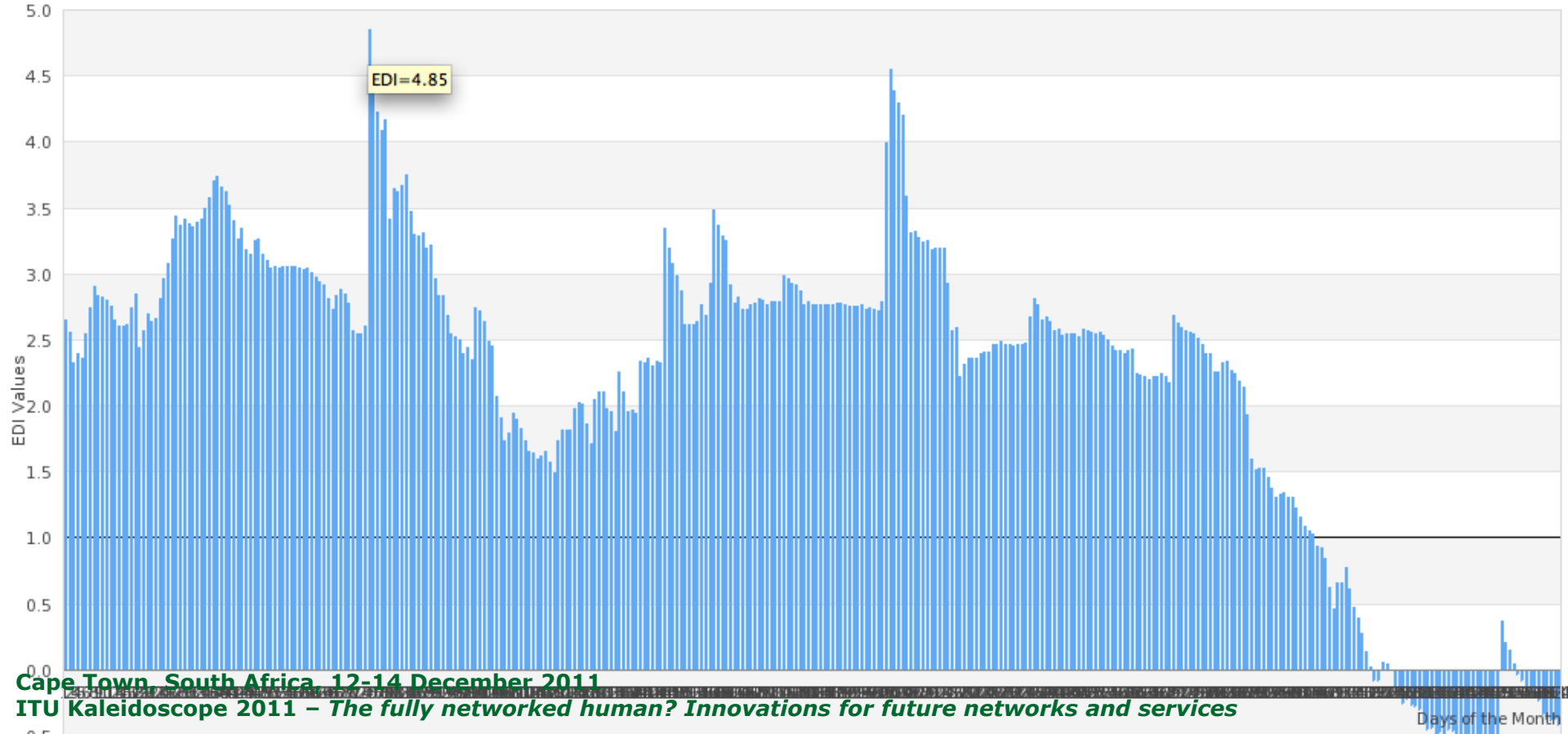
Graphical View

Figure 1. EDI Embu [March, 1998]



Graphical View

Figure 15. EDI for Dagoretti [January To December, 1998]



Conclusion

- **Quantifying Droughts/Floods**
  - The EDI web system can quantitatively and qualitatively identify that the drought;
  - example:
    - The 2009 drought started on 29th October 2008 for both Embu and Dagoretti and on 23rd October 2008 in Makindu.
    - The drought started worsening (below -1) on 15th March 2009 in Makindu, 22nd March in Embu and 10th April in Dagoretti. It subsided for 5 days (2nd to 6th November) in Embu and 5 days (18th to 22nd October) in Makindu
  - Support for Decision making is made easier, example:
    - EDI values together with weather forecast for March-April-May season would have saved human lives that were lost through Nairobi River floods

Further Work

- Incorporating the EDI system into the larger system
- Computing other parameters using the current (2011) data
- Incorporating Google Maps
- Linking the system to weather forecasts at KMD

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|M.D.R| Drought Index (EDI) Monitoring System

http://atmos.pknu.ac.kr/~intra3/eng/index.php

D.R| Drought Index (EDI) Monit...

Daily Drought Monitoring System using Drought Index over Korea

Meteorological Disaster Research

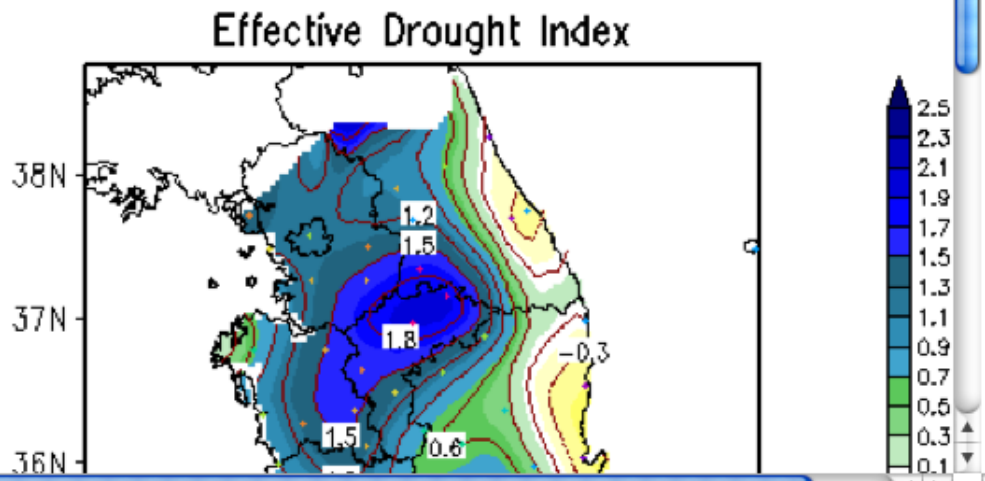
| Definition of drought | About EDI | Spatial distribution | Time

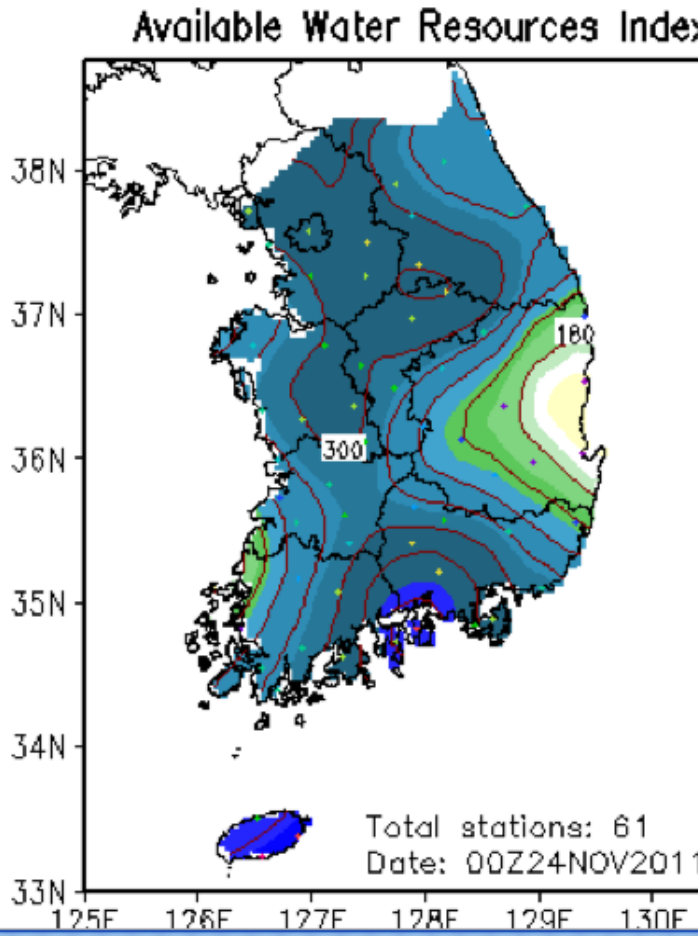
2011 11 24

Climatological year : 1981- 2010

Effective Drought Index (EDI)

	Moderate Drought	Severe Drought	Extreme Drought
Spring	-0.5 >	-1.0 >	-2.0 >
Rainy season	-1.0 >	-2.0 >	-3.0 >
Other season	-0.7 >	-1.5 >	-2.5 >





END….

- **Acknowledgement:** KMD for allowing access to the weather data
- Thank you
- Q & A