GLOBAL DROUGHT AND FLOODS IN 2009/10 EFFECTED BY ASTRONOMICAL CONDITIONS

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ABSTRACT

Tropical countries are dependent on supply of meteoric water from wind masses. Geographical features contribute to evaporation, wind motion and precipitation in addition to infiltration and run off. Srilankan hydrological patterns are described and the identified extreme conditions are studied. Climatic conditions are studied. Precipitation pattern at Galle, Kurunegala and Puttalam locations are studied for last 60years. Global warming of 1deg C is recorded in the same period. Human actions are responsible for the release of green house gases in to the lower troposphere. With the help of recorded values of temperature, precipitation, pressure and wind directions other influence from the Moon, Sun, Jupiter and Saturn are observed with smaller effects from Venus, Mars, Mercury, Uranus and Neptune.

Precipitation is a process influenced by Earth's gravitational pull as well as by other heavenly bodies. Monsoons are formed by declination of Sun. Inter-monsoons are formed due to the motion of the Sun over the island. The Moon as a sub planet has a gravity control like the Sun. The declination of Moon and its rotation round the Earth has a great control over precipitation and tides. The Sun has little control over tides. The declination of heavy planets and their positions contribute little effects to precipitation. The Moon has a combined effect with Earth and is responsible for long term droughts. The author forecasted drought in year 2001 in 1993 due to the common plane episode of Earth and Moon. It came in Sri Lanka and Brazil and other tropical countries as predicted. As planets revolve in a definite time scale effects are cyclic and can be accurately predicted. The next drought has come in 2010.

Scientists who have no clue about this effect take that as El Nino.

*KEYWORDS**: Droughts, Floods, Astronomical Effects***

INTRODUCTION

Tropical countries are periodically subjected to wind generated by annual Earth orbital motion. Monsoon is the wind carrying precipitation in South Asia and Southeast Asia. Recently due to global warming in climate, major changes took place in rainfall patterns. Earth orbital motion with fixed inclination of NS axis creates monsoon in Dec-Jan from NE and May-Jun from SW to precipitate water to Sri Lanka. In addition inter-monsoons caused by crossing the Sun over Sri Lanka come in September and April. Around the same time frontal type cyclones develop with heavy floods. Traditionally combined effect is used to compute the uncertainty of floods.

Global warming is a phenomenon in all tropical countries. South Asia has increased mean temperature by 1^0C during the last 60years.

Astronomical features observed during the same time revealed many cyclic events leading to floods and droughts. The common plane episode of Moon and Earth leads to a prolonged drought in tropics as happened in 1974, 1983, 1992 and 2001. The short-term effects of heavy planets like Jupiter and Saturn are causing floods in half year when the earth is in between them and Sun. Full moon days are rainy in Sri Lanka. These astronomical aspects are excluded in calculating the design floods for spillways.

The shift in precipitation made Hambanthota dry and Colombo wet. Embankment designs carry greater impact from this shift. 200year storm selected for spillway design is revised. Greater impact has shown over earth slips in wet zone. Dry zone old major tanks need rehabilitation to suit the new conditions. Each basin needs reassessment of certainty in parameters using fresh data. Coastal hydraulics needs designs to face Tsunami in addition to Sea erosion.

Discovery in droughts and floods is common to tropics. Brazil had the same drought in 2001 as predicted by the author in 1993. Astronomical features appeared in cyclic form during the last 30years when the global warming increased in tropical countries. Variation in rainfall patterns is a classic example of sources to identify exceptions. Flood hydrology is disturbed when the normal rainfall is concentrated to less duration and increased droughts cause insufficient water in the reservoirs.

1. SRILANKA GEOGRAPHY

Sri Lanka is an island in the Indian Ocean closer to South India with a high seasonal precipitation. Most of the precipitation is drained through the catchment basins at a faster rate and creates flooding at narrow locations of the river system. The main land is formed with a lower plateau of less than 300m of elevation. A mid plateau of 100-300m is forming the central mountains. A high plateau of 1000-2000m is in the central steep hill region. The highest peaks are in the upper Mahaweli Region having more than 2000m high peaks. Pidurutalagala, Kirigal potta and Kikilimana are high peaks. These high peaks are not getting high rainfall due to its location in the central highlands. Next important high peaks are around Samanala Range. It receives high average annual rainfall. Watawala records 5500mm average annual rainfall. This precipitation is the main source of freshwater in the island. There is no snowfall and glacier formation and hence all the water is drained through rivers. Western slopes are receiving more rains and Kalu, Kelani, Walawe Rivers drain from Samanala Range. Mid plateau of southwest slopes receive about 3000mm annual precipitation. Gin and Nilwala rivers drain from this area. Smaller rivers also drain to western sea. Ben River, Panadura River and Mahaoya are those important basins. All these basins contribute to flooding after heavy rains. Mahaweli River takes water towards dry zone. Galle is a coastal city in the southwest wet zone of Sri Lanka. Puttalam is in the Northwestern Province.

Early settlements were recorded in the history for 500000 years but the cultivation age was noted in 4000 years ago. The Arian civilization was the result of agricultural activity along water sources. Agricultural settlers used the coastal areas, river valleys, flat basins for cultivation. High mountains were left as protected areas. Sedimentation of rivers was limited to low natural limits. In 19^{th} century cash crops were introduced to central hills and sedimentation was doubled. The run off was increased and the villages near the rivers were subjected to floods. The specific yield of flow is increased in the wet zone. Rivers in dry zone originated from wet zone mountains, provided the necessary water for irrigation. In the drought period many streams dried and it was termed as Oya and dola basins. Ganga and ela are not drying in the year.

2. CLIMATE

The island is situated closer to Indian Peninsular and hence NE and SW monsoons are activated due to the revolution of the Earth round the Sun with an angle of inclination of 23.5^0 between the normal to the plane of revolution and NS axis of the Earth. The movement of the earth in that inclination creates movement of the Sun from Tropic of Cancer to Tropic of Capricorn. Northward motion begins from December 22 and Sun reaches vernal equinoxes in March 21. Then it enters the Northern hemisphere and reaches Tropic of Cancer in June 22. Then it begins southward motion and reaches vernal equinoxes in September 22. Then it enters Southern Hemisphere and reaches Tropic of Capricorn in December 22. As the position of the Sun changes from equator up and down wind stream movements begin towards the Sun. Heated wind streams rise up to create further motion. Cooler winds are attracted with high potential when the Sun is at extremes. Hence SW monsoons are in full swing in June. It begins in May and reaches Sri Lanka with high precipitation. Then it enters India and for June- September period provides rains. It goes through monsoon trough in Assam and passes along Himalayas in a northwest direction. Sri Lanka gets rainfall in May June

period. Early appearance and late disappearance brings more rain to the country. Major wind stream passes through Indian Ocean and it is rich with water vapor to satisfy about 1000 million people. But unfortunate situations arise as in 2001 due to the influence of moon to lead to a drought. In such situations the origin of winds was a landmass avoiding the sea.

The Southward Sun motion creates NE winds. Wind originates from Bay of Bengal and reaches Sri Lanka in the north and moves down to south. India is not getting rains from this NE wind as its origin is a landmass. Dry zone of Sri Lanka is fully benefited by these winds. November December months are usually rainy months. A change in the origin of winds may not carry full results. Sri Lanka is fortunate to have two inter monsoons created by the Sun passing across the island in April and September. March April period and October November period are rainy due to it. Due to effect of Moon these inter monsoon may be limited to very small rains as in 2001. In Sri Lanka cultivation season begins with inter monsoons in October. Coastal rains of convective type are coming to western and eastern coastal areas. Inter monsoons bring rains from many directions. The hilly regions are much benefited by this rainfall. But Hambanthota and Puttalam Districts are on the edge of the plate and hence get few rains. Badulla area receives rains from all four types of monsoons. Cyclonic wind patterns of frontal type occasionally develop in the Bay of Bengal and some times enter the island from the East. Early monsoons turn into cyclones in May and become dangerous. Cyclones brought heavy rains in Aug 1947, Dec 57, Dec 64, Nov 78 in the recent past.

3. CONDITIONS OF RAIN FALL

Dust form an essential role in rain formation. Presence of dust leads to nucleation of water drops and dynamic cooling of wind accelerates nucleation. Then it reaches point of saturation and releases drops of water. Insufficient dust storm is not able to form sufficient nuclei and the cloud passes the locality unsuccessfully. Cloud seeding is attempted in many occasions to spray cement dust or any other soft environment friendly material on to the cloud. The aircraft undergoes low pressure due to nucleation and needs quick escape. This operation is costly and rarely used. Dynamic heating of wind prevents further nucleation and absorbs water in to the wind mass and cloud disappears. Relative humidity drops in the downward motion of wind mass. This is the reason to precipitate rain along ascending path of the mountain and not on the other side. It can rain when it meets the ascending path of the next mountain range. Successive mountain ranges are responsible to account for heavy precipitation. Another drawback in this cause and effect is that, a change of wind direction results in low precipitation.

4. GLOBAL WARMING

Global warming is due to burning of fossil fuel in large quantities to produce high accumulation of green house gases. Carbon dioxide, ozone, ethane, propane, sulphur dioxide are heavy gases whose presence is catching more heat to lift up the mean temperature. Natural gases as by products of photo-synthesis, also collect in the lower troposphere. Solar energy is the source coming in short waves. Heat stores in the daytime using gases in the troposphere and water in the reservoirs and landmass in the continent. Emission in long waves slowly takes place in the afternoon and night. Cloud cover can reflect long waves back and form a green house to warm up the troposphere. This warming process is slowly building up during the last 60 years in the tropics. Temperature is measured twice daily at 9.00am and 5.00pm (CST) and a mean is recorded. Cloud cover in the wet zone reduces difference between maximum and minimum temperature. Highest temperature is recorded from Vavunia as 40.1^0C.

5. CERTAINTY CHANGES

5.1. Tsunamis (Coastal waves)

Earth as a planet contributes to variations of hydrosphere due to its volcanic eruptions located around plate boundaries. Indian Australian plate has the eastern boundary close to Andaman Islands. This zone is highly active in volcanic eruptions. Indonesia lies in the active zone of this plate with many active volcanoes. The dangerous tsunamis are caused by under water volcanic eruptions. In 1883 Krakato disaster was noted to form a Tsunami and killed 30 000 people in Jawa. A very same type disaster caused damage from Andaman and killed 120, 000 in Indonesia on December 26, 2004. Sri Lanka lost 36 000 people due to sudden waves propagated from Andaman in 2hours after the explosion. The eruption rated as 9.0 in the Richter scale and it lifted the bottom of the sea by 1km in a north south oriented long crack. The resulting waves propagated in the east and west directions. The dark water wave was 10m high and it carried water for about 2km in the Eastern coast. Also it attacked the Southern coast killing popular areas. Western coast is less affected but buildings were destroyed. Highly populated Western coast was not directly facing the Andaman Islands. This tsunami went to Maldives and then it attacked Somalia, Sey-shells. Coastal areas are rich with surface and under ground fresh water resources to attract high population. Tsunamis caused damage to them.

Dust emissions in 1883 reached atmosphere and visible for two years fading the sun light but not in 2004. History has recorded in 200BC a storm surge to destroy 500 villages in this country. It can be a tsunami. In 1615 another storm surge came. The economic damage is very high as the coastal population is 10% of the total. Tourism and fishing and industries dominate this coastal belt of 300m. Fresh water resources are more prominent in this coast. Damage to economy is very large due to complete eradication of villages and industries. Mixing of salinity with fresh water is long-term damage. Nobody expected tsunami as the memory runs back to 121 years. Storm surges occur in western coast with heavy sea erosion. Tidal waves combined with storms damage coastal beaches continuously. Groynes laid to protect eroded beaches are not attractive to tourists. Coral rocks are gradually destroyed by the acidity increase in the sea. Still water brings up concentration of acids around corals.

5.2. Floods

Global warming has increased the intensity of floods. The flood occurred in May 2003 on a full moon day was more devastating. It attacked Ratnapura, Galle, Matara, Hambanthoa, Kalutara, Nuwara eliya Districts. A 330mm one day rainfall was showered on southwest hill country due to a frontal type cyclone. This is computed as 50year storm. It came after a long drought in the beginning of SW monsoons. Usually a long drought builds up a heavy dust cloud in the atmosphere and finally it causes a sudden downpour when water vapor enters in major bulk. This type of extremes is noted after 1970. Global warming has increased the mean temperature by 1^0C in the last 60 years. This is noted in Sri Lanka, India and Nepal and commonly over the tropical areas. The main source of global warming is the burning of fossil fuels to produce mechanical energy. This is causing sea level rise by conduction and dissolution of ice caps. Hydrology cycle is increasingly affected as its operating temperature range is elongated. The result is a prolonged drought and a high precipitation. Tidal directions and flow are subjecting to change and the fish breeding grounds are disturbed. This is leading to alter fish catch and seasons. Flood control bunds are designed for 10year floods.

5.3. Droughts

Global warming has created a cycle of droughts over tropical countries. Usually there are four seasons to bring rainfall in to the island. The SW and NE monsoons are major rainy seasons. Inter monsoons are benefiting to begin the cultivation. Rainfed cultivations are postponed if inter-monsoons are delayed or absent. If monsoons are in short duration or absent, then total cultivation fails. Reservoirs in dry zone can store water and feed the crops. But wet zone perennial crops die in

the drought. Droughts in concentrated areas occur due to seasonal changes. In 2003/4 Maha season heavy drought affected Kurunegala District and vicinity. In late 2004, NE monsoons were high in central hills and Anuradhapura District. Floods caused several tank breaches. Potato farmers in Nuwaraeliya faced drought in Maha 2003/4. At the same time tsunami attacked coastal areas. Certainty changes in hydrology are heavily apparent in 2004. ICID had a theme topic as disasters on 2004 world water day. Farmers and dependents are facing heavy losses. Migration to wet zone is encouraged but tsunami discouraged coastal permanent occupation. Western Province bears 6M of population due to its sound water resources. Coastal districts carry 55% of population of Sri Lanka.

6. CHANGES IN HYDROLOGY

6.1. Kirindi Oya

Observations in precipitation in each district of Sri Lanka are available and some data was from 19th century. Kurunegala is in the intermediate zone in between wet and dry zones. Ratnapura is in wet zone in upper Kalu basin. Kirindi Oya is in the Hambanthota District receive some water from Badulla area. Kirindi oya basin in 1930 was rich with water and the estimate for irrigation was 24000ha and this was dropped to 12000ha when the Kirindioya project was planned. However it was dropped to 8000ha in 1978. In 1983 water yield was dropped to lowest level. In 1987 the project cultivated 8000ha but soon in 1992 it was dropped to 4000ha for two seasons. Further in 2001 the drought reduced the capacity to 1000ha and in 2002 rice crop was confined to 4000ha for one season and banana cultivation was given 1000ha. 2000ha of old farmers were given benefit of two seasons from the Ellagala anicut. Farmers with land lots had to return to old villages due to low yield of water. Complete drying of reservoir in 2001 restricted drinking water supply completely. Two surviving king coconut species in Hambanthota area were now extinct due to this drought. Failure of inter-monsoons led to destruction in this year with the common plane episode of Earth and Moon. Brazil faced a severe drought in this year as it lies in tropics like Sri Lanka. Menik river basin is planned to dam at Weheragala and 40% of water is diverted to Kirindioya tank.

6.2. Kurunegala

The average monthly precipitation was 150-200mm in the period 1950-1975 but it dropped to 120-200mm in the subsequent period 1975 to 2003. In addition it dropped to 80mm in 1987. It shows stabilization and gradual rise and fall in 30 years above 100mm (Figure 1). This area is far away to get high rainfall from Monsoons. A drop in patterns affect drinking water supply as well as irrigation.

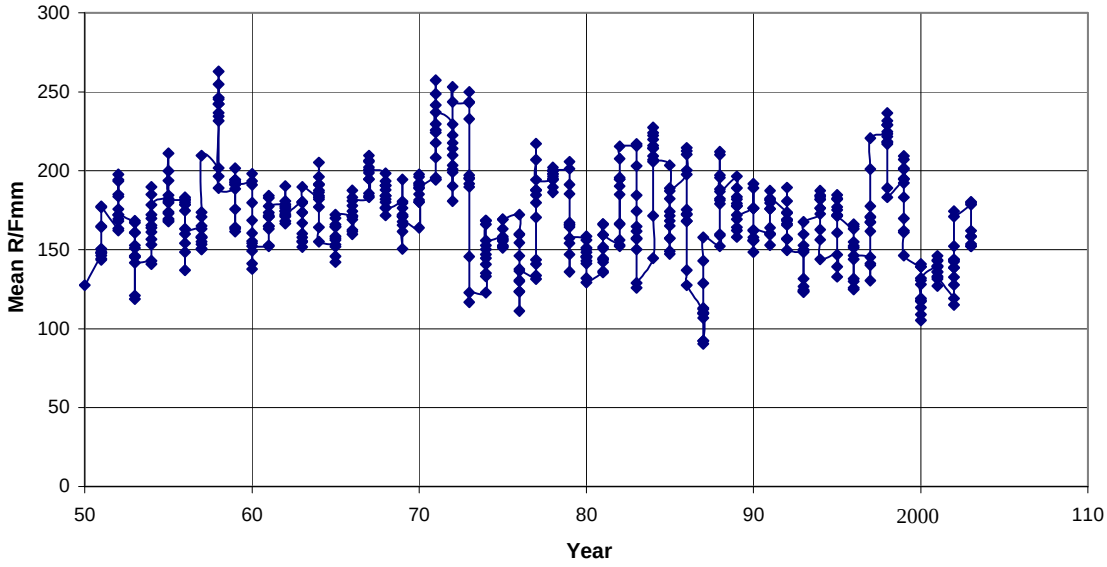


Figure 1. *12Month Running Average Precipitation in Kurunegala 1950-2003*

Table 1. Puttalam Monthly Precipitation and Annual Total in mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1973	0.0	33.0	56.6	128.8	79.2	126.7	15.2	5.3	1.3	323.1	91.2	411.0	1272
1974	0.0	62.2	21.8	281.7	86.1	11.2	19.1	47.8	33.3	3.0	108.0	84.6	759
1975	48.0	0.0	145.3	251.5	61.0	9.1	68.6	1.8	51.1	75.9	229.6	99.3	1041
1976	47.2	28.4	74.7	44.7	33.3	8.1	5.3	3.0	4.1	332.7	240.3	104.4	926
1977	36.1	0.5	181.6	183.6	281.7	11.9	15.0	14.7	27.7	424.7	186.9	85.6	1450
1978	0.4	0.4	176.3	170.8	178.2	3.6	4.4	10.4	8.0	228.8	547.1	170.7	1499
1979	1.6	53.6	0.0	48.6	0.1	5.2	10.4	22.1	159.1	187.8	352.5	220.6	1062
1980	0.0	0.0	1.5	174.9	16.9	83.9	5.5	0.5	196.7	194.1	292.3	56.5	1023
1981	16.9	34.1	60.8	124.5	123.1	59.1	2.5	23.9	87.6	126.9	360.0	32.6	1052
1982	0.0	0.0	24.9	88.3	100.8	120.6	9.8	3.3	20.1	289.9	239.5	67.1	964
1983	0.0	0.0	0.0	50.2	35.1	37.6	7.0	1.3	82.9	101.8	286.8	251.5	854
1984	279.7	226.2	257.4	652.6	33.2	0.1	77.1	0.0	62.7	78.7	438.4	62.8	2169
1985	73.2	219.5	60.5	116.1	220.9	15.5	0.5	0.0	107.9	192.6	435.7	94.6	1537
1986	69.5	51.7	28.1	144.0	136.4	10.8	0.0	8.0	17.3	145.4	145.1	63.6	820
1987	31.5	0.0	19.3	241.0	41.8	3.8	9.9	36.7	283.7	335.7	156.0	52.5	1212
1988	15.8	56.9	52.5	408.5	7.5	118.1	13.3	44.7	141.6	53.9	202.7	67.2	1183
1989	22.7	0.0	60.6	162.5	16.7	15.9	13.7	0.4	19.4	248.2	240.6	26.8	828
1990	217.0	0.0	35.2	33.5	291.7	0.5	3.4	0.4	2.4	380.3	225.1	180.7	1370
1991	54.0	8.3	79.3	106.6	250.8	101.5	7.6	1.2	12.9	342.3	228.4	88.4	1281
1992	5.7	0.0	0.0	93.8	174.9	38.2	82.3	9.6	38.5	287.1	288.7	59.0	1078
1993	4.9	10.1	78.7	118.6	105.9	0.7	9.2	6.4	45.8	244.4	239.1	317.2	1181
1994	109.0	100.9	72.9	60.6	76.4	0.2	35.2	6.4	169.0	250.8	186.6	36.5	1105
1995	66.6	80.0	30.2	312.5	194.0	7.7	19.1	1.1	0.4	192.5	463.2	24.4	1392
1996	28.6	70.0	0.4	172.9	56.3	103.9	2.0	43.5	145.5	279.0	96.3	114.1	1113
1997	0.2	4.4	7.4	64.7	149.1	58.9	16.7	0.0	72.2	253.6	400.2	73.4	1101
1998	36.1	6.3	35.3	47.2	186.4	12.4	151.9	25.9	51.6	104.1	323.5	202.1	1183
1999	90.7	110.8	0.0	154.7	45.2	11.6	1.3	3.3	61.4	246.4	171.1	69.0	966
2000	111.3	79.3	41.2	154.2	7.4	5.8	0.0	80.1	100.1	45.8	161.1	161.5	948
2001	114.5	44.7	0.0	327.6	13.2	51.9	87.3	0.2	24.1	46.4	199.3	115.1	1024
2002	20.9	36.1	138.6	410.5	100.9	11.5	0.0	0.8	14.0	334.1	237.8	279.9	1585
2003	106.5	7.7	142.1	190.4	99.3	93.3	133.9	12.2	3.4				

Effectivr rainfall = 0.67(R-25) mm

6.3. Puttalam

Annual precipitation is very low in Puttalam (Table 1) District. It is around 1000mm. But in drought periods it drops to 820mm. SW monsoons shift to India in June with the Kerala mountains covering Puttalam, Mannar and Jaffna Districts. Despite coastal rains in the coastal area interior Mi Oya basin is very dry and expects storage in Tabbowa and Inginimitiya tanks.

Puttalam has gained exceptional rains in 2002 and 1984. This was in contrast to the pattern shown by other locations. These two years were common drought years and heavy precipitation has recorded after the drought. The change in rainfall patterns in Sri Lanka is accommodated with a shift in NW direction in these exceptional years.

6.4. Dry Zone

Dry zone area has commonly dropped precipitation but shows stability. The 1850mm isohyet demarcates the wet zone boundary. About one third of Sri Lanka falls in to wet zone. This wet area is shrinking. Matara city now falls out of wet zone. The Sinharaja natural forest lost many trees and reduced to scrubs from SE direction. Matara and Hambanthota Districts need diversion from Nilwala and Gin rivers for town expansion. Cooler areas of Nuwaraeliya, Bandarawela lost morning mist and coolness in morning. Only Colombo and Matara districts had slight increase from the mean of 1960-90 and dry zone had the worst hit. NE monsoons lost 19% and next Inter monsoons lost 10%. Malale

district reduced rains by 410mm during 50 years as the worst. Districtwise increases are Colombo 60mm Matara 30mm and decreases are Vavunia 25mm, Hambanthota 40mm, Kalutara 50mm, Puttalam 60mm, Galle 80mm, Mannar 90mm, Trinco 120mm, Jaffna 120mm, Kilino 130mm, Anurada 130mm, Polonna 135mm, Batti 160mm, Kuru 160mm, Monera 160mm, Mulaitiv 170mm, Kegalle 200mm, Nuwaraeli 200mm, Badulla 220mm, Ampara 250mm, Kandy 315mm and Matale 410mm.

6.5. Ratnapura

Ratnapura District in the boundary of wet zone is gradually reducing the level of precipitation. Storage tanks are not planned due to its low head but floods create difficulties in civil life. Earth slips are increasing due to increased sudden one-day storms. Increased population lives on dangerous sites in the hills, also plant tea bushes in place of big trees. This increases the risk of earth slips. Increased uncertainty demands more drainage facility. Also flood control and relief measures need more attention. Water is a resource, which can be diverted to drought areas. But still 60% of precipitation goes to the sea. Gem mining is leading to soil erosion. Mini hydropower projects are operated during wet season.

7. WEATHER PATTERNS

Sri Lanka has a very good record of hydrology data for the last 200 years. Historical records show tsunami, storm surges, droughts, floods and epidemics. Beminitiya was a drought existed for 12 years from 45BC. This led the need to write down hither to by hearted Buddhist texts on ola leaves at Alu vihara Temple. Dry zone major tanks had very low storages due to droughts. Agricultural development in tea, rubber and coconut performed by British maintained rain gauges in estates.

7.1. Observed pattern

Rainfall patterns are usually changing but mean of Galle rainfall data (Table 2) is maintaining close to 2300mm. Annual rainfall in 1974, 1983, 1992, 2001 showed a drop when compared with rest of the years. Galle is facing the sea and SW monsoons are directly reaching without any obstruction. **The research conducted by the author discovered this phenomenon in 1993 and forecasted the drought in 2001 and 2010.** This pattern is no doubt attributed to astronomical features. The drought becomes so serious due to global warming. There was no serious report on drought before 1973. Stable atmosphere causes high-pressure situation. High pressure is causing drought in the island.

7.2. Destabilizing forces

Tides are caused by gravity pull of Sun and Moon. When Earth and Moon taken together the resultant center of gravity lies over the earth surface. Rotation of Earth in the eastward direction rotates the center of gravity westward with same speed of 1600km/hour. This center drags water towards it and in doing so reach a peak in 6 hours and ends in 12hours. Direction changes in 12 hours and low tides begin. It reaches a peak in 6 hours and ends the cycle in another 6 hours. Westward rivers show this phenomenon to take high tides a long distance. Ben River takes water up to Hattaka. Boats took that advantage to travel up stream.

Sun is the other object to alter the tides. Its effect is about 10% of that of the Moon. On the full moon days the two forces are canceling each other. On new moon days the two forces are added together. We can see rainfall differences on these different days. Full moons are usually rainy days. When Earth comes to the middle water has free movement and rain is more.

Tides are changing according to the declination of Moon. Direction of tides is changing accordingly. Declination envelope of Moon is changing from $18,5^0$ to $28,5^0$ in 18.55year cycle. In this cycle it reaches the coplanar position in 9.25years. This episode came in drought years in Sri Lanka as noted above. The coplanar activity of Earth and Moon taking place for two-year period is very calm and clouds are not seen in the sky. Usual showers are not matured to give sufficient rains. All the tropical areas are affected to this drought. Brazilian drought came in 2001 in the same period as in Sri Lanka, [Seneviratne, (1993)].

7.3. Short-term effects

Droughts lasting for 3month period and excessive floods appearing in tropical countries can have astronomical reasons. Declination and position of Jupiter and Saturn is important. Jupiter and Saturn are heavy objects in the solar system. Jupiter balances the system by pushing Sun back and has some influence on water. Its period of revolution is 12 years. Every year half the period it is visible in the outer orbit in the night. Rest of the year it moves to the other side of the Sun and is not visible in the night. When it is visible in the night we are in between Jupiter and Sun. Hence it is a chance for free movement of water and rainfall continues. Same case is repeated for Saturn, which has a period of 30 years. These two planets come near in 20 years. The impact of combined planets is greater in years around 1961, 1981, 2001 than the years around 1971, 1991and 2011 due to positioning. Precipitation in 1980, 1981and 1982 September months was more than January February months of same years (Table 2).

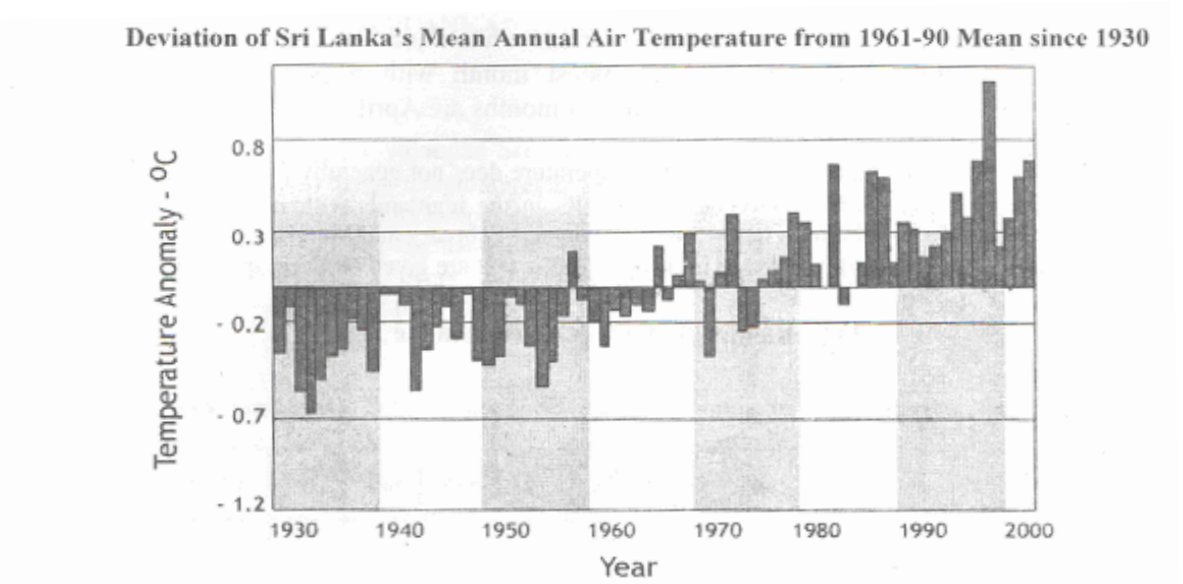
Table 2. *Monthly Precipitation at Galle, Sri Lanka in mm*

YEAR	Jan mm	Feb Mm	Mar Mm	Apr Mm	May Mm	Jun Mm	Jul mm	Aug Mm	Sep Mm	Oct mm	Nov Mm	Dec mm	Total Mm
73	**36.3**	65.8	213.9	**109.7**	263.7	364.2	239.0	128.5	157.5	422.4	196.6	113.8	2311.4
74	**0.5**	**73.2**	**54.4**	408.2	393.4	193.8	365.5	140.7	394.2	**45.2**	208.0	121.4	2398.5
75	88.9	85.3	156.7	342.1	180.6	286.0	144.8	162.1	155.4	352.3	324.1	106.4	2384.7
76	95.8	**18.3**	87.1	397.8	163.6	99.6	170.7	111.0	50.8	350.0	750.3	312.7	2607.7
77	**8.9**	264.2	118.1	**100.8**	312.4	139.4	**78.5**	157.2	168.4	469.1	410.5	114.8	2342.3
78	84.7	90.1	143.3	178.8	390.1	200.0	**70.7**	**28.5**	217.6	**141.7**	425.6	119.1	2090.2
79	53.9	102.0	69.3	219.1	233.6	286.9	198.1	**36.6**	468.5	299.0	657.6	181.2	2805.8
80	125.	**46.0**	63.4	171.3	**102.3**	126.5	**61.3**	148.8	416.4	244.5	286.0	476.4	2267.9
81	102.	83.2	88.7	273.0	394.0	**52.8**	**44.8**	147.9	148.0	239.9	305.9	205.8	2086.0
82	**17.3**	**1.8**	151.3	421.3	322.0	235.4	191.9	158.6	174.6	218.6	577.1	**87.3**	2557.2
83	76.4	**0.6**	**54.5**	**18.7**	**110.1**	122.6	113.5	150.7	338.0	180.2	**144.6**	240.0	1549.9
84	212.	102.1	60.5	304.2	466.4	**28.0**	149.6	**18.8**	**28.1**	**98.8**	310.3	106.6	1885.4
85	139.	114.0	91.7	**82.1**	212.5	402.2	**71.6**	229.3	159.2	525.9	224.1	240.7	2492.7
86	63.2	60.1	151.8	148.8	224.1	**79.1**	**31.1**	90.3	122.0	223.3	131.0	186.4	1693.2
87	87.7	**3.7**	**5.1**	242.6	**140.6**	237.2	**8.1**	476.9	334.1	523.5	335.3	**71.7**	2466.5
88	92.0	114.0	225.4	222.7	228.1	328.4	224.7	301.9	249.3	**60.1**	260.7	**83.6**	2390.9
89	86.7	**23.0**	66.6	322.1	386.1	228.7	141.1	118.9	179.2	428.9	284.0	**58.0**	2323.3
90	**37.3**	**44.3**	**44.7**	432.5	179.2	147.6	170.0	187.0	320.0	348.4	214.5	125.3	2250.8
91	140.	**42.1**	**20.7**	159.8	545.1	138.4	105.8	116.1	100.7	391.9	169.5	178.3	2153.9
92	**47.6**	**0.2**	**4.7**	**64.1**	**5.5**	203.7	**5.9**	88.7	**5.3**	201.7	378.7	88.2	**1094.3**
93	**15.9**	**11.7**	**51.8**	209.2	738.7	283.4	151.3	**50.6**	201.8	180.2	294.4	283.5	2472.5
94	89.9	78.8	58.3	262.9	317.1	**59.3**	283.4	156.6	461.1	621.9	84.7	124.5	2598.9
95	89.1	67.5	**17.3**	377.4	327.1	472.1	125.8	196.5	**69.2**	261.2	309.4	**8.7**	2321.3
96	98.8	105.5	103.5	203.7	**69.8**	256.3	163.5	**77.8**	470.1	174.2	**145.0**	102.1	1970.3
97	**15.2**	54.6	**23.3**	**40.5**	**129.2**	128.2	256.4	150.2	425.4	407.7	319.3	144.3	2150.3
98	50.2	**33.4**	**15.1**	**77.2**	**117.3**	234.0	405.0	176.1	203.2	270.0	**22.1**	490.0	2093.6
99	115.	137.3	14.2	523.0	385.2	191.1	109.0	120.2	329.0	795.0	**127.2**	119.0	2864.2
00	236.	112.2	281.1	210.3	288.3	192.1	**59.2**	215.0	323.0	**157.3**	298.5	145.7	2519.0
01	97.7	103.4	163.5	186.0	**99.4**	**89.7**	**85.0**	**46.4**	150.0	387.3	157.9	205.3	1771.6
02	**40.0**	**49.7**	**56.8**	**57.4**	234.2	**54.6**	118.1	**52.7**	**98.5**	312.8	322.7	139.2	1533.7
Av	99.0	103.0	115.0	225.0	298.0	191.0	196.0	166.0	243.0	342.0	307.0	187.0	2470

Av=Mean Precipitation of 1951-1980 period
Monthly precipitation below half of the mean is given in bold face. Source: Hydrology Annual

7.4. Long Term Effects

The effect of Moon creating a drought when the two planes are coinciding is a long-term effect. Some times the drought extends to 18 months. It has shown a gradual extension from 1974 to 2001. This can be attributed to global warming. Tropical countries are subjected to this event. Astronomical features are similar to those lands with same geographic conditions and subjected to atmospheric pressure changes due to wind. Brazil, Indonesia and Sub Saharan Sahel countries face a drought with Sri Lanka in 2010. Tsunami is a rare occasion created by sudden lift of ocean floor for about 1km. High floods are occurring due to various changes in the atmosphere. Consistent changes need proper designing of spillways, embankments and drainage canals to suit the new changes. Early detection of a disaster minimizes the losses due to it. Augmentation is necessary to divert water from available basin to a depleted basin. Planning of new projects needs serious consideration of water resources management.



It is noteworthy to mention that the global mean surface temperature has increased by between 0.6 ± 0.2 ^{O}C since the late 19th century which has been attributed to increasing concentrations of greenhouse gases due to rapid industrial growth (IPCC, 2001).

8. CONCLUSION

Sri Lanka has 103 river basins including 14 perennial rivers. Many river basins discharge high floodwater to sea in the event of floods. At the same time global warming is continuing to show adverse impacts on hydrology. Increasing droughts and high intensity rainfall are developing during the last 30 years. Certainty changes are applicable to alter design parameters of old projects and take precaution for new projects to minimize the cost and maximize benefits.

Identification of astronomical impacts leads to proper planning of agricultural projects. Drought prediction has saved many losses by taking suitable actions without investing. Irrigation projects need design of embankment with suitable storage justified by projected hydrology. Canal system needs high efficiency to distribute water to command area. Hydrology changes abandon most of the projects and it is useful for all tropical countries for experience. The next drought was predicted in 2010 for all tropical countries. Agriculturists need to take care for rain-fed (hena) shifting farming in the wet zone of Sri Lanka. Young tea bushes dry during drought. As the Earth in January 4th is farthest from Sun and slows down the crust of Earth become weaker. On the full moon day Earth is pulled from both sides and becomes highly weak. Eruptions are likely in this period as happened in December full moon day. Tropical areas show more freedom for raining during full moon days. Tropical countries include Sri Lanka, India, Indonesia, Malaysia, Singapore, Australia, Ethiopia, Somalia, Sudan, Sahelian Countries, Brazil, Peru, Equador, Colombia.

Tidal changes in the cycle affect fish catch and regular fish breeding. Drought mitigation activities are needed in the island. Previous records show that all common plane episodes of Earth and Moon had droughts except in 1928.

Verification of common plane episode in the early period is commensurate with the 1965(66), 55(55), 47(47), 37(38), 18(18), 1909(08/09). However in the middle a seasonal drought occurs as in 1979, 1976, 1968, 1958, 1950, 1945, 1934, 1923, 1914/15 which resulted for other reasons other than astronomical. Little drought came in 1928. Hydrology records in the other tropical countries need a comparison for this episode.

REFERENCES

[1] SENEVIRATNE, L. W., Drought Forecasting, *Irrigation Department, Colombo, Sri Lanka* 1993.