GE03
PV water pumping for irrigation harvesting rain water

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***Abstract*-In this paper the application of the first PV pump using only for irrigation harvesting rain water in a projected area Gomastapur of the district Nawabganj in Bangladesh has been assessed with reference to ecology and agriculture practices. Due to the absent of electricity in this area cultivation is only seen in monsoon. Though more than 60% of the total cropped area is under severe drought, supplemental irrigation is not practiced, resulting in the decrease of crop production even more than 90%. The fall of ground water level is noticed in the neighboring areas due to excess extraction. Considering the behavior of the climate change PV pumping has been suggested for lifting water from a pond in the contest of drought for supplemental irrigation harvesting rain water.**

INTRODUCTION

Climate change mainly refers to temperature rise; other associated changes which may result from climate change are in precipitation, evaporation and humidity etc. all these changes again cause the most threatening impacts in natural, social and economic systems. Human induced changes in the global climate and associated sea level rise are widely accepted with policy makers and scientists. With the climate change, these factors will affect agriculture most.

Bangladesh is an agro based country. Agriculture contributes about 21% to GDP [1]. With the sea level rise, a vast land in the southern coastal belt will go under water. This will reduce the existing crop area severely thereby hampering agricultural productions.

About 77% of total irrigated area is under groundwater irrigation [2]. So with the climate change, this sector will face terrible shortage of surface and ground water. Climate change, particularly the higher temperature will increase the evapotranspiration resulting in more water demand and exploitation of groundwater, scarcity of groundwater resources, and increase in winter temperature affecting areas suitable for wheat, pulse and vegetable, increased spikelet sterility and reduced crop yield. Again lower rain fall due to climate change will enhance higher rate groundwater withdrawal but due to lower recharge to the aquifers, most of the suction mode tube wells will go dry in the lean period. As a result, new tube wells have to be installed to greater depths at the expense of higher installation cost which will increase irrigation cost as well. Thus, the climate change will greatly affect irrigation economy.

Due to erratic climatic conditions, more areas are expected to come under water restrictions in near future [3, 4]. In most parts of Bangladesh, water table shows natural annual fluctuation from 3.6 m but fail to return to its previous years' level at the end of the rainy season [5, 6]. The dry period groundwater table fluctuation largely depends on the amount of monsoon rainfalls. With change of climate, the reduced rain fall availability will further deteriorate the groundwater availability. The result is the scarcity of both drinking and irrigation waters creating acute health and good problems. In this situation PV water pumping of surface water harvesting the rain water is a good solution.

ABOUT THE AREA

The pump is located in the village Ginarpur situated in the sub district Gomastapur, a part of district Nawabganj of Rajshahi division. The clay is underlain by red-brown silty sands, sands and gravels and aquifers that are the groundwater source in the northeastern part of the study area. Sediments in the top 26 m of the profile have 5 000-year-old radiocarbon dates. The surface is thought to be the top erosion surface of the Barind clay and underlying sediments are therefore considered much older Barind sediments. The geological properties in the Barind Tract posses multiple problems related to water-holding capacity and recurring drought [7, 8].

CROPPING SYSTEMS

In the projected area farmers only cultivate the *Aman* rice in monsoon. During drought period *Aman* crop suffers from high-yield reduction. Farmers do not practice supplemental irrigation during drought as it requires substantial investment. They mainly depend on rainfall. If there is not enough rain then the plantation is delayed. Delayed transplanting of *aman* rice reduces the yield and leaves no land to grow short-duration vegetables, oil seeds (mustard) and pulses (chick pea) etc.

Effect of drought

Droughts caused by varying rainfall patterns occur frequently in many parts of Bangladesh, causing substantial damage and loss to agriculture sectors. Every year, 3 to 4 million hectares of land are affected by droughts of different magnitudes [9]. Drought impact, associated with late or early monsoon rains or even complete failure of monsoon is quite common in the projected area. Drought can affect the rice crop in three different seasons. Droughts in March and April prevent timely land preparation and ploughing, delaying planting of crops during monsoon season. Inadequate rains in July and August delay transplantation of *aman* in highland areas, while droughts in September and October reduce yields of both broadcast and transplanted aman and delay sowing of pulses and potatoes. *Boro*, *wheat* and other crops grown in the dry season (summer) are also periodically affected by drought [10].

Way to overcome

Optimal use of groundwater is a possible solution. But in terms of groundwater usage, some areas are already

under threat of over-abstraction. Availability of groundwater is therefore a very pertinent question. Indiscriminate proliferation of deep tube wells is responsible for this. However, this is not environmentally friendly. So rain water harvesting is a good solution when we will take environment pollution in to consideration.

Rain water harvesting

Rainwater harvesting and recycling are essential to manage seasonal droughts through supplemental irrigation. Significantly high rainfall variability is observed in the drought-prone areas, with different types of seasonal droughts (initial, mid and terminal) posing major threats to rice production. Yet, often, high intensity rainfall is wasted due to non-availability of proper storage structures. So we need to concentrate on rainwater harvesting, recycling and conservation.

METEOROLOGICAL DATA

Rainfall: Normally the rainy season lasts for June to August [8]. The annual rainfall and seasonal rainfall in this zone are closely related because more than 70 percent of the rainfall comes during monsoon season [10]. Fig. 1 shows the rain fall condition of the pre and post month along with the monsoon season [11, 12].

Fig. 3 shows the rain fall deviation of last two years from the normal rainfall condition. In the month May and June the deviation is totally opposite for the last two years. Compare to 2008 the deviation is quite large in the year 2009 where in the month June and July the deviation is higher and negative. It is clearly the sign of drought. Without supplemental irrigation in these periods there will be huge reduction in crop production.

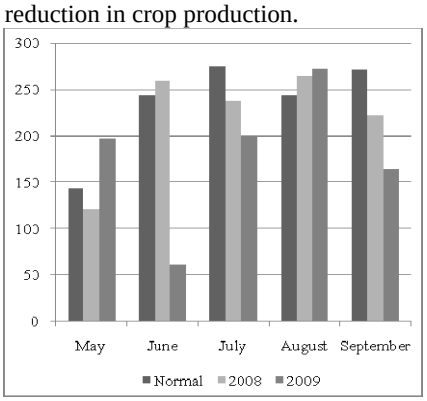

Fig. 1: Rainfall during monsoon

Temperature: The maximum and minimum temperature of the North West part of Bangladesh is shown in fig. 3 [13]. Highest maximum and minimum temperature occurs in April and August respectively.

Ground water level: Groundwater is used for irrigation in the dry season especially for *Boro* rice, which requires very high amount of water. In recent years, over exploitation has led to rapid fall in the groundwater of neighboring areas [10].

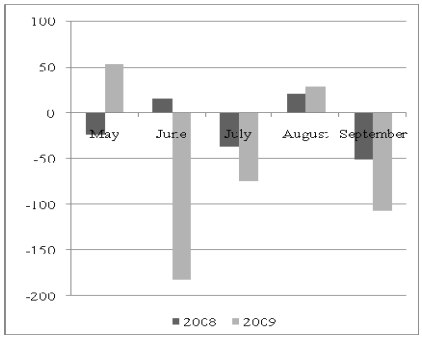

Fig. 2: Rainfall deviation from normal.

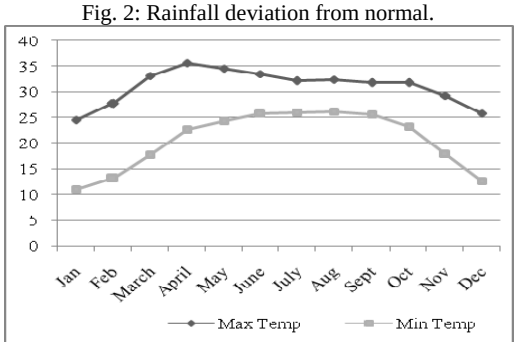

Fig. 3: Average temperature of the North West region

It will create serious problems for the environment and agricultural production in the future especially when combined with climate change. In the projected area ground water is not over utilized as they do not cultivate in dry season. So the level is not downward. For RL parapet 43.84m the ground water level of the projected area is shown in fig. 4 [14].

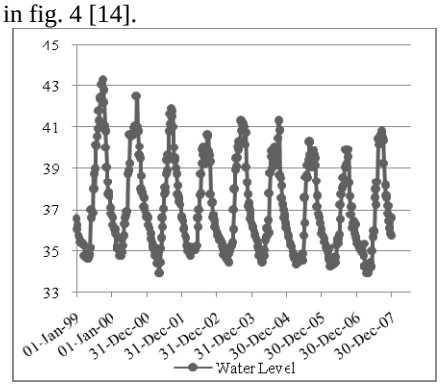

Fig. 4: Grown water level of the projected area for RL parapet 43.84 m.

PV PUMP

The use of photovoltaic as the power source for pumping water is one of the most promising areas in photovoltaic applications. Photovoltaic water pumping systems are particularly suitable for water supply in remote areas, where no electricity supply is available. Water can be pumped during the day and stored in tanks, making water available at night or when it is cloudy.

The advantages of using water pumps powered by photovoltaic systems include low maintenance, ease of installation, reliability and the matching between the powers generated and the water usage needs. In addition, water tanks can be used instead of batteries in photovoltaic pumping systems.

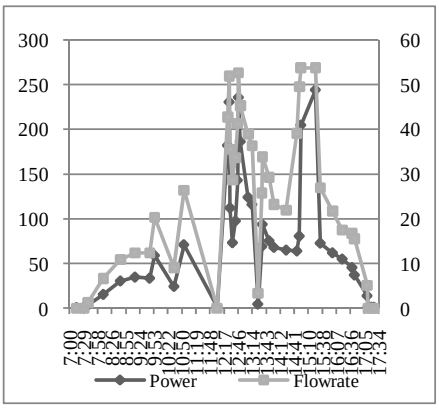

Fig. 5: Array power and Flow rate of a worst day condition

In PV water pumping the motor pump setup can be used directly connecting it with the array when the motor is DC. On the other case for AC motor it is connected via inverter. DC motors have a common disadvantage associated with the sliding brush contacts and commutator that require a frequent maintenance [15]. For submersible application, maintaining and replacing brushes need the pump to be removed from the well thus increasing running cost. Generally, DC motors suffer from maintenance problem [16]. To overcome this drawback, brushless DC motor can be introduced [17]. Here the Mono Pump Sun-Sub Solar Water Pumping System is used. The rated power of the total set up is 300 watt. 4 modules (BP 375) are connected in series with each 75 watt. Brush less parmanent magnet submersible DC motor with output power rating of 300 W is used. Maximum speed of the pump is 3000 rpm.

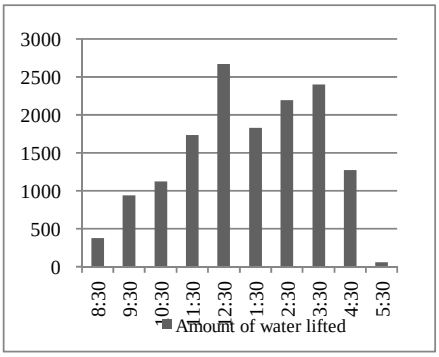

Fig. 6: Amount of water lifted.

AREA UNDER IRRIGATION

In drought prone areas the supplemental irrigation can increase the production up to 50%. The water required for supplemental irrigation in *Aman* season varies from 20 to 30 cm (height). So the water required for per hectare land varies from 800 to 1200 m^3 [9]. The dimension of the pond is 30.48 X 30.48 X3.05 m^3. Considering the rainfall and the usage of water for house hold works, it is possible to irrigate 4 to 5 acres of land during *Aman* season. It is also possible to get the irrigation facilities after the *Amon* season during minor crop cultivation. Not only that, through out the year they can use the water for household works.

CONCLUSION

Bangladesh will be the main victim due the climate change of the world. Climate change is not only an environmental concern but also a development concern for Bangladesh. This means that climate change as an issue must come out of the environmental problems to take center stage as a major development problem. So we should take the step 1st to protect the climate change. PV technology along with other renewable energy will be a good start. As Bangladesh is a land of agriculture and a large portion of the water pump is driven by diesel for irrigation purpose it will be an effective step to replace these pumps by PV pump at least in those areas where electricity facility is not available. In parallel harvesting the rain water will prevent the fall of ground water level and ensure the easy availability of fresh water in near future.

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