Predicting Meat Production for Saudi Arabia in 2030: Comparison with Five Regional Countries

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***Abstract*—The rapid growth in demand for animal and animal products has been termed as the livestock revolution. This "revolution" is driven by rising income and changing consumer preferences, particularly among a growing middle class. However, the question is, what would be the situation 15 years from now? Thus, there is a need to predict the agriculture scenario in 2030 with reference to production of fodder and feed vis-à-vis pastures; which is required for meat production. In this paper, we study the impact of agro-meteorological and socio-economic parameters of water scarcity, CO_2 fertilization and climatic-change vulnerability in 2030 on pasture yields, and how this effects meat production as reported in the FAO 2011 report. The results for Saudi Arabia are compared with five regional countries i.e. Egypt, Iraq, Jordan, Lebanon and Yemen. The combined impact of the parameters considered had an overall positive impact on Lebanon and Jordan mainly due to CO_2 fertilization.**

***Index Terms*—prediction, CO_2 fertilization, climatic-change vulnerability, water scarcity, data mining, pasture**

I. Introduction

The livestock sector in the world continues to experience rapid structural changes. The rapid growth in the demand for livestock products has been termed the livestock revolution. This is because of the rising income, expansion of cities, and changing consumer preferences among a growing middle-class [1]. There are new trends in the developing countries like demand for safer food and higher quality livestock products [2], [3] which is also true for the Middle-Eastern countries considered. However, due to number of factors such as water scarcity, climatic vulnerability etc. do these countries have the comparative advantge in field crop production w.r.t fodder (from pasture) and feed in the year 2030? This being the major thesis of this paper.

We start with the income elasticity. Consider, Jordan, income elasticity for meat is 0.743 and for fish this being 0.846 i.e. for every percentage point increase in income, the spending on meat will increase by 0.772% and for fish increase by 0.883% [4], [5]. Other than demand, production and purchase, there are many factors affecting the field crop production either negatively or positively.

Some studies have discussed the influence of these factors on the production of meat for Middle East, but there are almost no studies that discuss the production issues for countries such as, Egypt, Iraq, Jordan, Lebanon, Saudi Arabia and Yemen w.r.t CO_2 fertilization, climate change vulnerability and water scarcity as discussed in this paper.

Global population will evidently continue to grow and may increase from 6.8 billion to 8.3 billion by 2030, leading to an expected increase in demand for grain and animal-source foods and dairy products. There is a rising middle class desiring more animal source foods and dairy products resulting in an increase in demand for water and arable land; which in the case of Saudi Arabia is on a decline [6], and there is a need to predict and identify potential cultivable regions that are suitable for further study to ensure food security. Finally, we expect the world's climate to continue to change in ways that could impede food production and dislocate people [7].

Agriculture produce consists of items which the humans consume, and the by-products being consumed by the animals as fodder (from pasture) and feed by poultry. Of course animal fodder (Rhodes grass, Alfalfa) and feed (corn, soya bean) crops are also grown for direct consumption by livestock. Different agro-meteorological parameters have a profound impact on the agriculture produce i.e. resulting in increase or decreases in production, which in turn effect the prices, meat production and consequently the food security.

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Table I [8]-[10] is a comparison of the six countries by taking into consideration some of the relevant factors, such as agriculture land, agriculture production and population.

TABLE I. COMPARISON OF SIX COUNTRIES CONSIDERED

	Land (Sq-Km)	Production (M tons)	Population
Egypt	36,418	110	81,836,973
Iraq	81,150	999	29,309,503
Jordan	1,006	114	6,364,245
Lebanon	6,150	95	4,064,346
Saudi Arabia	1,734,293	97	27,174,193
Yemen	235,000	129	23,616,253

Rest of the paper is organized as follows, in Section II a general background is provided, in Section III related work for the meat forecasting in the region is given, in Section IV materials and methods are discussed which are used in our study, Section V provides the discussion and results and finally, last section conclusions.

II. BACKGROUND

In developed countries production of quality meat is usually achieved through feeding of high-energy rations to young animals. However, the bulk of meat produced in the developing countries still comes from rather extensive system activities. These extensive systems are operated by the same people on virtually the same grazings or pasture land. For extensive pasture-based systems, there is a linear relationship between live animal weight and animal age in years [11] i.e. pastures and meat production is highly correlated. Therefore, for 2030 we predict the impact of three paremters on pastures yields (w.r.t fodder and feed) for six Middle East countries and study the impact on meat production as per the FAO 2011 report. Most of the Middle-East region is characterized by a hot and dry climate and the presence of vast deserts and long coast lines [12]. Deserts cover large areas while agricultural lands are defined as the arable land that are under perennial grass pastures or crops, but covering small areas [13]. Climate change is considered the biggest threat on the planet affecting the availability of water and causing food crises while the population is on the rise [14]. There are far-reaching consequences of climate change on agriculture production, such as drought that can increase the vulnerability of livestock [14]. There are two ways of responding to the agro-meteorological and socio-economic changes i.e. adaptation and mitigation. Adaptation helps people to deal with changes while mitigation reduces the impact or magnitude of changes in the long term [15], adaption being one of the main objectives of this paper.

Due to climate change there will be frequent droughts and floods resulting in epidemics and vector borne diseases, discussed in Section VI. These changes may lead to increased food shortage and loss of lives ultimately resulting in loss of genetic resources. All these changes will impact grasslands, pastures concequently livestock production and their health if proper adaptations and mitigation measures are not taken, livestock producers may suffer substantial losses [12].

III. RELATED WORK

With the increasing requirement and need to predict the animal source food demand vis-à-vis pastures, many researchers have addressed the corresponding issues, for example [16]-[21].

In [16]-[18], the rises in atmospheric concentration of CO_2 and subsequent climatic changes have been discussed for 2050. As per [16] climate change may also adversely affect the prospect of achieving food security improvements, since most climate models indicate that agricultural potential of developing countries may be more adversely affected than the world average. The high dependence of several of these countries on agriculture makes them particularly vulnerable in this respect. Different [17], [18] climatic factors will drive global warming, but can also be a positive factor in tree and crop growth and biomass production. Since CO_2 fertilization stimulates photosynthesis and improves water-use efficiency [19], therefore, up to 2030 this effect could compensate for much or all of the yield reduction coming from temperature and rainfall changes, however, this is expected for most countries of the northern hemisphere. Although, these studies discuss the parameters that we have considered, however, the discussion is not at the country level as per our study.

In [20] forecast of red beef is studied for various Gulf Cooperation Council (GCC) countries from 2012-2015. Population growth in GCC countries is predicted to increase by 7% with the total population reaching over 47 million in 2015. According to the growth in GCC region, beef consumption was forecasted to increase to 314,000 tons between 2010 and 2015. The growth in food consumption forecasted for Saudi Arabia to increase by 53.3% in 2017. However, the impact of the three parameters that we have considered was not discussed and the time period considered was significantly less as compared to our study.

In [21] demand for the next five years of the region was forecasted for various grains by-products, some of which being used as animal fodder grown in pastures. It was concluded that the population growth is expected to bolster the demand for livestock products, consequently causing increase in demand for barely especially in Saudi Arabia, which is the largest barely importer. It was expected that Saudi Arabia will be accounting for around 39% of total world barely trade in 2018/2019. However, the impact of the three parameters that we have considered was not discussed and the time period considered was significantly less as compared to our study.

According to [17], as per the United Nations population projections, there is a dramatic slowdown in the world population growth as compared to the historical trends. This being a pleasant surprise, as it is in contrast with the increasingly pessimistic predictions about the fate of global environment. Although population growth is still on the rise, but the slower growth rate means a corresponding decrease in future water scarcity as was previously anticipated. However, this is not a global phenomenon, because for regions such as Africa, the Middle East and parts of Asia, population growth will continue to put pressure on available fresh-water resources well into the 21st century, thus making these regions vulnerable to food security.

IV. Materials and Method

FAO-2011 report consists of number of tables containing data about production and consumption of mutton, poultry and beef for 104 countries for the years 2000 and 2030 with predicted change in meat production [22]. The study presents the data for several Middle-East countries, including Saudi Arabia. The eight variables considered in the FAO-2011 report are given in Table II [22].

TABLE II. Variables Considered in the FAO-2011 Report

Generic Type	Variables
Locational	Longitude, latitude
Anthropogenic	Distance to roads Distance to city lights
Demographic	Human population
Topographic	Elevation
Land cover	Normalised difference vegetation index (NDVI)
Temperature	Land surface temperature Air temperature Middle-infrared
Water and moisture	Vapour pressure deficit Distance to rivers Cold cloud duration Potential evapotranspiration
General climatic	Modelled length of growing period
Other	Tsetse distribution (for Africa)

In this paper, we will discuss the effect of three additional variables/factors (inclusive of a meta variable) on meat production for 2030 for six countries vis-à-vis pastures. The heterogeneous data for this study was gathered from diverse sources which was subsequently extracted, transformed and integrated prior to the analysis.

In this paper we will use traditional techniques as well as data mining [23] to analyze the impact of the diverse data collected and integrated for the three factors on percentage change in meat production from 2000 and 2030. In order to make the study manageable we shall not consider data on eggs and milk.

A. Global Climatic-Change Vulnerability

Climate change will not only affect livestock population and health, but may also have significant effect on environment, socio-economic, water resources, agriculture/food security, human health, terrestrial ecosystems, biodiversity and coastal zones to name a few. Excess or scant rainfall may lead to floods or droughts. Flooding due to melting of glaciers may cause soil erosion. Crop growing seasons may get affected due to rising temperatures and consequently affect food production and security.

Around 50 countries in the world are vulnerable to climate change and may suffer by climate impacts [24]. The researchers carried out a study on pre-existing characteristics of society that are known to be affected by climate change and mapped it to the level of vulnerability.

The expected climate change (meta variable considered) impacts were analyzed and four factors were considered [24]:

- **Health impact:** Diseases that are sensitive to climate changes may cause more deaths.
- **Weather disasters:** Changes in weather, damage due to storms, floods and wildfires may cause additional loss of lives.
- **Habitat loss:** Rising sea water, reduction of dry/ arid land may lead to loss of human habitat.
- **Economic stress:** When agricultural land is lost, there will be loss of natural resources which may lead to economic loss.

The impact of these four factors was color-coded qualitatively [24], which we converted into quantitative values ranging from 11 to 1 as Acute (11), Severe, High (with finer gradation of + and –) followed by Moderate and Low (1). The average percentage change of the qualitative values was subsequently taken for each country, and the results shown in Fig. 2. Note that, the smaller the vulnerability index, the better.

B. CO_2 Fertilization

The structure and functioning of ecosystem and human livelihood are mainly affected by changes in thermal and hydrological systems which are in turn affected by changes in climate. Climate change is mainly due to a set of physical coherent changes in meteorological variables, based on the normally accepted levels of CO_2 and other trace gases. To estimate the effects on crop yields, how much land could be cultivated, and the number and type of crop combinations that can be cultivated, Fisher [25] developed climate change scenarios using AEZ (Agro-Ecological Zone) family crop models. AEZ is a model that uses detailed agronomic-based knowledge to assess options of farm-level management, simulate the availability of land resources and estimate potentials of crop production [25].

As per [25], climate change in 2050 will not have any impact on crop production in Central Asia; however, other developing countries will have a negative impact. On the contrary it was predicted that production capacity of rain-fed cultivated land in Europe, Russia and Oceania will increase. From [25], even with CO_2 fertilization for adopted crops there could be a decrease of 8% in cereal production in Middle-East, but there is an increase of 14-19% in Central Asia for crops without CO_2 fertilization. The CO_2 fertilization results for 2050 however do not directly help us; because the level of detail is at the region level i.e. Middle-East instead of an individual Middle-East country level that is the focus of this paper. Therefore, we need average country-level CO_2 fertilization data, which is then mapped to 2030/50.

For CO_2 fertilization at country level, we use the corresponding color-coded image data [26] as shown in Fig. 1 that covers the period from 1982 to 2010 and uses different colors to indicate the increase or reduction in leaf production.

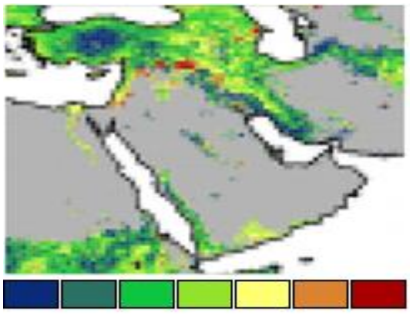

Figure 1. Mapping satellite data showing percent amount foliage cover change around Middle-East from 1982 to 2010.

We proceed by determining the average CO_2 fertilization for each Middle-East country considered and then adjusting it w.r.t 2030 for the entire Middle-East region.

To get an average value of CO_2 fertilization for each Middle-East country considered, the best way is to determine the change in WUE (Water Use Efficiency) for that country while assuming a universal change in CO_2 concentration for the study period using data available at Mauna Loa [27]. However, this methodology is beyond the scope of this paper, therefore, we performed online image processing and subsequent data mining for each Middle-East country for the percentage amount that foliage cover has changed from 1982-2010 using Red, Green and Blue color values of image in Fig. 2 determined using the Image Color Summarizer [28]. Because of manuscript space constraints we are unable to include further details. The calculated CO_2 fertilization for the six countries considered is shown in Fig. 2.

C. Water Scarcity

As per [29], Water Scarcity (WS) is understood to be the lack of access to adequate quantities of water for human and environmental uses. This is increasingly being recognized in many countries as a serious and growing concern. Currently, 166 million people in 18 countries are suffering from water scarcity, while almost 270 million more in 11 additional countries are considered water stressed [30]. Nearly half a billion people in 31 countries face water shortage problems, a figure that is anticipated to rise to nearly two-thirds of the world population by 2025. The worst areas comprise the entire Mediterranean region, including parts of North Africa and Middle East. In Middle East countries like Jordan, Yemen and others with rising water scarcity, more than 40% of the available water cannot be traced [31]. These countries will face severe water shortages in the coming years. The water scarcity values for each of the six countries considered are shown in Table III [30], [31].

Water stress occurs when the demand for water exceeds the available amount during a certain period or when water supplies drop below 1,700m^3 per person, or when poor water quality restricts its use. When annual water supplies drop below 1,000 m^3 per person, the population is considered to be water scarce, and below 500 m^3 "absolute scarcity" [32]. In this paper we will use the water scarcity figures based on [33] given in Fig. 2 for the six countries considered.

TABEL III. MODERATE WATER SCARCITY PROJECTIONS FOR THE SIX MIDDLE-EAST COUNTRIES

Country	1995		Medium projection 2050		% change with medium projection	
	Population	m^3/person	Population	m^3/person	Population	m^3/person
Egypt	62,096	936	95,766	607	54.22	-35.15
Iraq	20,095	5,434	41,600	2,625	107.02	-51.69
Jordan	5,373	328	11,894	144	121.37	-54.72
Lebanon	3,009	1,854	4,424	1,261	47.03	-31.98
Saudi Arabia	18,255	249	42,363	107	132.06	-57.03
Yemen	15,027	346	39,589	131	163.45	-62.14

V. RESULTS AND DISCUSSION

In this section we will analyses the impact of the three factors/parameters i.e. water scarcity [33] CO_2 fertilization [19], [20] and the climate change vulnerability [18] (meta parameter) for Saudi Arabia and compare with selected five Middle-East countries. We start by exploring the meat (beef, mutton and poultry) consumption for the six Middle-East countries based on the collective effect of three parameters; the summarized results are shown in Fig. 2.

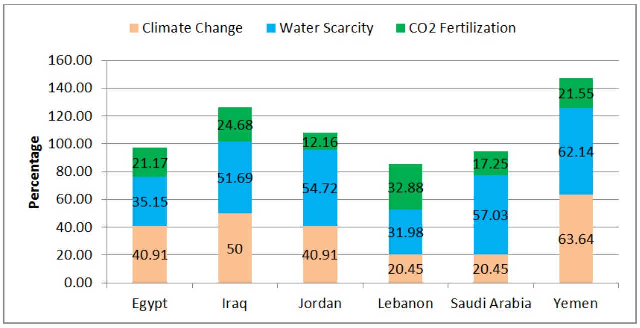

Figure 2. Comparison of Saudi Arabia with Egypt, Iraq, Jordan, Lebanon and Yemen for the three parameters considered.

There is a generic relationship between water use efficiency of plants i.e. transpiration and the production of biomass. Water stress will result in reduction of transpiration, which will also negatively affect biomass production, resulting in reduction of yield. As per [32], as the yield responds to water, similarly there is possible reduction in yield proportional to the reduction in evapotranspiration. Thus, a high WS is undesirable, as it will result in weak forecasts of crops, fodder and feed. On the same note [32], crop yield usually responds positively to an increase in atmospheric CO_2 fertilization i.e. higher CO_2 concentration resulting in higher yields both for the cultivated and modified crops. Subsequently an increase in crop yield and corresponding increase in fodder for animals that directly supports meat production.

There are four sub-factors that can be considered in the computation of the meta-climate change vulnerability factor [23] which are: health impact, weather disasters, habitat loss and economic stress. These factors will negatively affect the production. Therefore, we define the Effective Percentage Change in Production i.e. EPCP as (1):

$$EPCP = (CDF \times (1\text{-}CCV) \times PCMP)/(WS) \quad (1)$$

here CDF is CO_2 Fertilization, CCV is Climatic-Change Vulnerability, and PCMP is Percentage Change in Meat Production. The corresponding results are shown in Fig. 3.

From Fig. 3, we can observe that the percentage change in production of mutton for Yemen without considering the three factors is expected to be 415.5% for 2030; however, if we consider the three factors then the effective production is expected to reduce to 51.87%. By adjusting the demand using the three factors, we can observe that there will be a reduction in production of beef by 75.7%, reduction in production of mutton by 77.4% and reduction in production of poultry by 75.8% in all the six countries for 2030. However in the case of Jordan there is an increase of 86% in production for 2030. Hence, Jordan is expected to benefit from CO_2 fertilization.

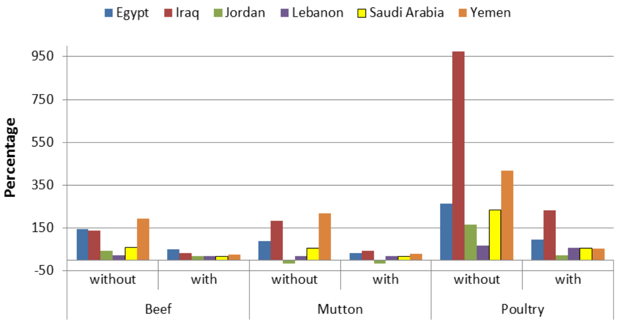

Figure 3. Percentage change in predicted meat production in 2030 without and with the impact of the three parameters considered

As per [34], dependence on food imports in general is high across MENA (Middle East North Africa) region nearly complete (around or above 90 percent) in all GCC economies, except Saudi Arabia where it is 80 percent. Thus, the impact of world food price fluctuations will have the pass through effect from world to domestic prices would be largest in the GCC economies, as well as in some other regional countries, such as Yemen, Iraq, and Jordan. Observe the similarity of our results (Fig. 3) with that of [34] keeping in view the relationship between production and demand.

VI. Conclusions

In this paper, we have used a data-driven approach to analyze the projected meat production in 2030 w.r.t. fodder and feed production for pastures in Saudi Arabia. Subsequently a comparison with five regional countries i.e. Egypt, Iraq, Jordan, Lebanon and Yemen by considering the agro-meteorological and socio-economic parametres of water scarcity, CO_2 fertilization and climatic-change vulnerability. Other studies have not considered these factors for predictive analysis.

To have a comprehensive study, we considered countries from three income categories i.e. low, medium and high. Thus the countries considered being Egypt, Iraq, Jordan and Lebanon from the category of lower middle income level, Yemen being low income category and Saudi Arabia from high income category. By considering the three factors, a decrease in pasture production (fodder and feed) and subsequent reduction in meat production is projected from 2011 to 2030 for the countries considered. Lebanon being an exception because of low climate change vulnerability and high CO_2 fertilization. Jordan is expected to be positively affected due to better CO_2 fertilization, as CO_2 fertilization results in an increase in plant biomass, photosynthetic production rate and water use efficeny. As part of future work, using agro-meteorological and seasonal climate data, performing predictive GIS data mining to generate pasture prediction maps. The prediction maps will identify those regions of the Kingdom, where pastures are currently not cultivated, but have high probability of cultivation success.

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References

[1] C. L Delgado, M. W. Rosegrant, and S. Meijer, “Livestock to 2020: The revolution continues,” in *Proc. Annual Meetings of the International Agricultural Trade Research Consortium*, Auckland, New Zealand, 2001.
[2] A. Rosati, A. Tewolde, and C. Mosconi, *Animal Production and Animal Science Worldwide*, Wageningen Academic Pub., 2005.
[3] J. V. D. Steeg, M. Rakotoarisoa, N. An, P. V. Breugel, and M. Herrero, “Farming systems diversity, does it matter for the poor?” in *Porc. Conference on International Agricultural Research for Development*, University of Göttingen, October 9-11, 2007.
[4] J. Seale, A. Regmi, and J. Bernstein, “International evidence on food consumption patterns,” Technical Bulletin, US Department of Agriculture, 2003.
[5] *PDPE Database on Elasticities Economic Research Service*, Department of Agriculture International Food Consumption Patterns Datasets, United States, 2007.
[6] O. Ouda, “Impacts of agricultural policy on irrigation water demand: Case study Saudi Arabia,” *International Journal of Water Resources Development*, vol. 30, no. 2, pp. 282-292, 2014.
[7] J. Beddington, “2030: The perfect storm scenario,” The Population Institute, Washington, DC, USA, 2010.
[8] The World Bank Group. (2014). Agricultural land (sq. km). [Online]. Available: http://data.worldbank.org/indicator/AG.LND.AGRI.K2
[9] O. Kit, *Turn Down the Heat: Confronting the New Climate Normal*, World Bank Publications, 2014.
[10] *Food and Agricture Organization*, Country Pasture Profiles, 2015.
[11] P. Auriol, “Intensive feeding systems for beef production in developing countries,” *World Animal Review*, 1974.
[12] J. V. D. Steeg and M. Tibbo, *Livestock and Climate Change in the Near East Region*, Cairo: Regional Office for the Near East, Food and Agriculture Organization of the United Nations, 2012.
[13] W. Killmann, “Climate change and food security: A framework document,” Food and Agriculture Organization, pp. 1-110, 2008.
[14] P. Thornton, M. Herrero, and P. Ericksen, “Livestock and climate change,” *Livestock Exchange Issue Brief*, no. 3, 2011.
[15] C. Calvosa, D. Chuluunbaatar, and K. Fara, “Livestock and climate change,” International Fund for Agricultural Development, pp. 1-20, 2009.
[16] N. Alexandratos and J. Bruinsma, “World agriculture towards 2030/2050: The 2012 revision (No. 12-03),” *ESA Working Paper*, 2012.
[17] J. Bruinsma, “World agriculture: Towards 2015/2030: An FAO perspective,” *Earthscan*, 2003.

[18] V. Linehan, *et al.*, "Global food production and prices to 2050," presented at the 43rd Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) Outlook Conf., March 2013, vol. 13, pp. 1-37.
[19] F. Bazzaz and W. Sombroek, *Global Climate Change and Agricultural Production: Direct and Indirect Effects of Changing Hydrological, Pedological and Plant Physiological Processes*, Chichester, UK: John Wiley, 1996.
[20] B. Larkin, "MENA: Income, oil, government budgets, meat consumption and trade," Red Meat Market Report, June 2013.
[21] C. Wharf, "Five-Year global supply and demand projections," International Grains Council, England, June 2014.
[22] T. P. Robinson and F. Pozzi, "Mapping supply and demand for animal-source foods to 2030," *FAO Animal Production and Health Working Paper*, no. 2, Rome, 2011.
[23] A. Abdullah and A. Hussain, "A cognitively-inspired approach to two-way cluster extraction from one-way clustered data," *Cognitive Computation Journal*, vol. 7, pp. 161-182, June 2014.
[24] McKinnon, *et al.*, "Climate vulnerability monitor," *DARA*, pp. 1-290, 2010.
[25] G. Fischer, "World food and agriculture to 2030/50," in *Proc. Expert Meeting on How to Feed the World*, 2009.
[26] Z. Mintz, "Deserts are 'greening' from carbon dioxide fertilization, satellite imagery saw arid regions bloom," *International Business Times*, New York, USA, 2013.
[27] *Trends in Atmospheric Carbon Dioxide*, NOAA Earth System Research Laboratory, 2015.
[28] Image color summarizer. [Online]. Available: http://mkweb.bcgsc.ca/color_summarizer/?
[29] C. White, "Understanding water scarcity: Definitions and measurements," in *Proc. Global Water Forum*, 2012.
[30] T. Gardner-Outlaw and R. Engelman, *Sustaining Water, Easing Scarcity: A Second Update*, Population Action International, 1999.
[31] A. Lalzad, "An overview of the Global Water Problems and Solutions," *Lecture*, London, 2007.
[32] J. Doorenbos and A. H. Kasssam, "Yield response to water," *FAO Irrigation and Drainage Paper*, no. 33, FAO, Rome, 1979.
[33] T. Gardner-Outlaw and R. Engelman, "Sustaining water, easing scarcity: A second update," *Population and Environment Program*, pp. 1-20, 1999.
[34] E. Ianchovichina, J. Loening, and C. Wood, "How vulnerable are Arab countries to global food price shocks?" *World Bank Policy Research Working Paper*, 2012

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