I changed the title to give it a political importance as following;

Politics Impact, Diesel Availability, Groundwater Accessibility Nexus In Yemen
Implications of 2011 Diesel Crisis

- **Introduction**
  Should highlight the following:
  - How much groundwater is considered as an important water source for semi arid region such as Yemen.
  - How much politics play/ or non play an important role on the availability of groundwater for different user sector especially for agriculture activity.

- **Objectives**
  Should be modified in a manner that put the assessment of political role an advantage over other aspects

- **Political Consequences Actual Yemen Groundwater Situation**
  In each following points we should say why this situation exists (Give a reason/s related to a negative political action/s, such as non implication of water law or neglecting / delaying proper recharging of GW aquifers
  - A Glance On Water Balance of Yemen
  - State of Groundwater Basins of Yemen
  - Anatomy of Yemen's Wells
  - Groundwater Mining: A fundamental threat to the wellbeing of the Yemeni people

- **Political consequences Actual Yemen's Agriculture Sector**
  In this point we should monitor how much the importance of groundwater as a source for irrigation water to the agricultural activities in Yemen. Also monitoring the negative political effect of delaying implication of ban of random well drilling and insufficient governmental action on reducing water consumption in agriculture sector, and its result on low irrigation method efficient and less water use efficiency and crop water productivity.

- **Political consequences Availability of Diesel (Pumping Source Power)**
  In the following points we should monitor the importance of diesel for agriculture sector as the main source of power and the different political action that had been taken to manage the distribution of diesel to agriculture users?
  - Diesel and Groundwater Pumping Nexus
    - Diesel as Energy Source for Water Pumping
    - Diesel Consumption for Water Pumping
    - Diesel Use for Pumping Water in Some Basins
    - Diesel Consumption for Some Crops Under Surface Irrigation

        - Distribution of Fuel Consumption Amongst Economy Sectors
        - Comparison of Diesel Consumption by Governorates

- **Implications of 2011 Diesel Crisis**
  This will be our case study (the survey that we effectuated) we should answer; How it started? Why politics?
    - **Political Impacts On Diesel Crisis 2011, Groundwater and Agriculture Nexus**
      Here we explain**;** What were the consequences? What its affect on below topics? How farmers deal with such shortage of diesel?
        - Impact on Water Pumping
        - Impact on Diesel Consumption
        - Impact on Black Market
        - Impact on Agricultural Productivity
        - Impact on products market chain
        - Impact on Groundwater level
        - Impact on Yemeni Farmers
    - **Political Action and Reaction Towards Solution**
      Then we give a brief about chronicle of diesel crisis and its subsidy and smuggling then the negotiations between political player and the motivations, arguments of each side and answer; Who benefit from it? What were the politics action/s and reaction/s?
        - Chronicle of Diesel Crisis in Yemen
        - Importance of Petroleum Subsidies
        - Diesel Smuggling
        - Inter Government and Parliament Debates
        - Effect of Agreement on Yemeni Farmers

- **Learning Lessons**
    - WHO IS/ARE RESSPONSIBLE?
    - Water Needs and Politic Unfair Games
    - The Need of Sustainable Source Power For Groundwater Pumping

- Introduction

Yemen depend mainly on diesel fuel as the most important source of energy needed for pumping irrigation water that satisfy crops irrigation water requirements. So, relation between diesel and agricultural productivity is so tied and any shortage in diesel could cause decreasing in crops yield and threatens food security.

Yemen has a very long history of irrigated agriculture where surface runoff irrigation, as one of the earliest irrigation techniques in the region, was practiced since 7000 years ago. Results of archaeological survey and radiocarbon dating confirm that irrigation originated in Southwest Arabia during the mid 6^{th} millennium BP (Harrower, 2006). However, starting from 1960s there was a rapid shift from traditional surface runoff irrigation to groundwater irrigation. Tubewell technology was thought to be the most welcomed advent for modernization of rural economy and it has been supported directly or indirectly by the government and donor funded projects. As a result, the total irrigated area doubled in the three decades from 1970: now over 40% of farmed land is irrigated. The rapid spread of new irrigation technology has not only altered irrigation practices but also changed the cropping patterns – the area under cash crops has shot up from 3% of the total in 1970 to 14% today, and production of high value fruit and vegetables has increased by 20 times, from 40,000 tons annually in 1970 to 800,000 tons today. Full or supplemental well irrigation now accounts for two thirds of the value of crop production, and despite ever increasing pumping depths, groundwater use remains currently financially profitable in many areas and for many crops (World Bank, 2010).

Many factors have contributed to the uncontrolled race for well irrigation. Huge revenues of Yemeni expatriate in the Gulf region was sought to be the most source for financing well construction. Agriculture attracted investors due to strong demand and profitability of some irrigated crops and the rapid growth of markets for irrigated crop production, particularly for qat. But, at the same time well irrigation was helped by a favorable incentive framework: cheap diesel, cheap credit, the absence of duties on equipment, an import ban on competing cash crops, active government support through projects, and the absence of any regulatory framework.

No doubt these developments brought prosperity for the rural community and preserve the status of agriculture as the most important productive sector although no longer the dominant sector. In 2006, agriculture accounted for 33% of employment and 9% of GDP (World Bank, 2010).

However, one unexpected threat emerged from behind the sense: the water crisis. Water crisis is regarded as the most prominent security challenge facing Yemen in its recent history. This crisis is manifested by the very rapid mining of groundwater, extreme water supply shortages in the major cities, and limited access of the population to safe drinking water. The main causes of the water crisis are clear: rising demand as population grows and as market-led agriculture develops; groundwater exploitation getting out of hand; an incentive framework that has promoted expansion rather than efficient use and sustainable management; and very weak governance

(World Bank 2005). Water consumption in the irrigation sector continues to increase at an average rate of 30 MCM/year or 5% per year. Already by 1990, irrigated agriculture alone was consuming 130% of Yemen's renewable water resources. By 2005, this had reached over 150%. If expansion were to continue, the overdraft would reach 200% by 2025 – although many aquifers would be pumped dry before then (World Bank 2005).

Diesel engines are used throughout Yemen as a source for energy for groundwater pumping. But diesel fuel is sold in Yemen at a price much less than its import price. Government is pushed by the World Bank to remove diesel subsidies since subsidies are regarded as one of the elements of the incentive framework that drove groundwater overdraft. However, the Government has been reluctant to increase the diesel price to import parity levels, despite recognizing that cheap energy has played a role in driving groundwater overdraft. The concerns of Government are about impact on poor and fears of political unrest. Despite sharp price increases in the last ten years, the Government still subsidizes prices of USD 0.28 per litre (USD 1.08 per gallon) for diesel.

The political crisis of the year 2011 in Yemen and concurrent public unrest and conflicts affected the fuel marketing chain in the country including cease of fuel imports and partial or complete shutdown of the only two local refineries. At one stage the Government was compelled to undertake extremely unexpected decision: complete lift of gasoline fuel subsidies. At that time, the minister of trade and industry "Hisham Sharaf" quoted; "The main problem is the diesel pricing. The government is incurring huge losses because of the diesel subsidies, which reach as high as 70 percent. Now, the government has reached a critical financial point and can't pay for imported fuel and sell it at such a low price". He added "When the subsidies were lifted and fuel was sold at an internationally regulated price the problem was resolved" (Yemen Times, 28-11-2011).

This paper describes finding of a rapid assessment study of the effect of diesel crisis of 2011 and the subsequent increases in diesel prices on the agricultural sector, particularly the effects on groundwater pumping patterns. An analysis of the correlation between diesel consumption of each governorate and groundwater pumping was also given.

- Objectives
    - To understand the importance of the groundwater as a source of water supply in Yemen and the threats on sustainability of the source
    - To present the dependence of Yemen agriculture on groundwater pumping
    - To study the impact of 2011 Yemen diesel crisis on water pumping and agricultural activities
    - To understand the role of politics in pricing and use of diesel as energy source for groundwater pumping

- A glance on water balance of Yemen

Yemen annual water consumption is 3.4 billion cubic meters approximately (Table 1). More than 90% of it goes to meet agriculture demand, from which only 40% is actually used by plants while the remaining percentage is lost by deep percolation or evaporation.

The annual renewable water is estimated of 2.5 billion cubic meters (1.5 billion m^3 as surface water and 1 billion m^3 as ground water). So, to fill the gap between annual water resources available and annual water demand 0.9 billion m^3 of groundwater withdrawer every year from more than 50 thousands wells until 2003 (Yemen Nature report 2003). This number of wells drilled all around Yemen had been increased rapidly to reach 70,000 wells in nowadays (NWRA inventory of wells, 2009).

Table (1): A glance on water balance of Yemen

Total water uses for all sectors	3.4 BCM	
Total annual surface runoff In the Wadis	1.0 BCM	30% of total use
Total groundwater abstraction	2.4 BCM	70 % of total use
Annual groundwater recharge	1.5 BMC	
Annual groundwater depletion (deficit) (groundwater abstraction - groundwater recharge)	0.9 BCM	
Total renewable water resources (annual surface runoff+ groundwater recharge)	2.5 BCM	

- State of Groundwater Basins of Yemen

With the exciting water shortage that represent 26% and the need to provide irrigation water required to cultivated crops a huge number of illegal wells drilled every year all around Yemen out of governmental regulations. This disturbing of wells drilling and excessive ground water extracting caused rapid annual groundwater level drawdown (figure 1) as in Sana'a (6-8 m), Tehama (1-3 m), Saddah (5-6 m), Amran (3 m), Taiz (1.75-2 m) and Abien (0.2-1 m)…etc (Yemen Nature report 2003).

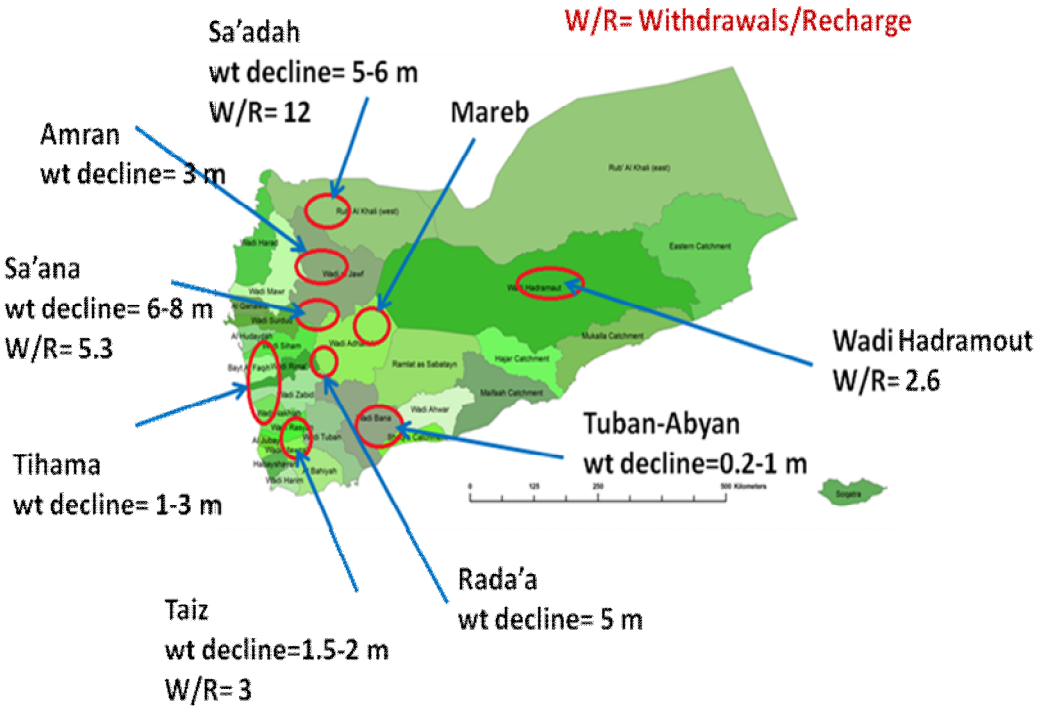


Figure (1): State of Groundwater Basins of Yemen

- Anatomy of Yemen's Wells

Figures (2-a and 2-b) below show two examples of wells anatomy in Wadi As'ssir and Wadi Surdud

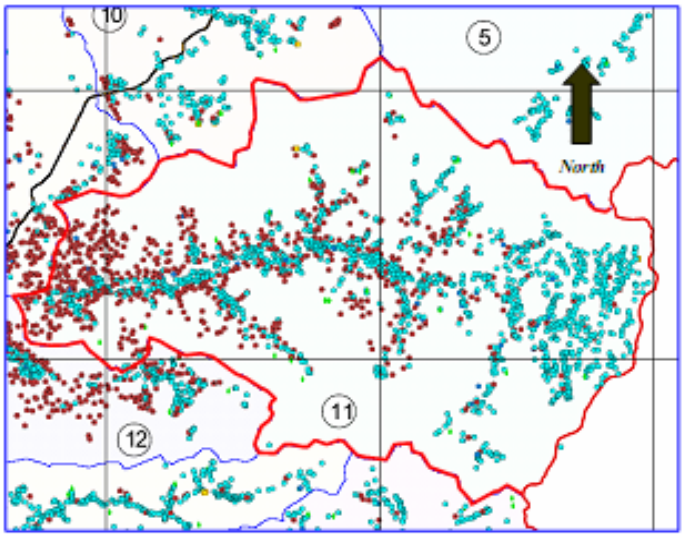


Figure (2-a): wells anatomy in Wadi As'ssir

Figure (2-a) shows who much the excessive number of wells distributed as dark red spots in Wadi As'ssir which has the highest well density in Sana'a basin. As it appear from the figure drilled wells concentrated at the west of the Wadi and decreased in numbers with the direction toward the middle, and has the lowest concentration at the eastern region.

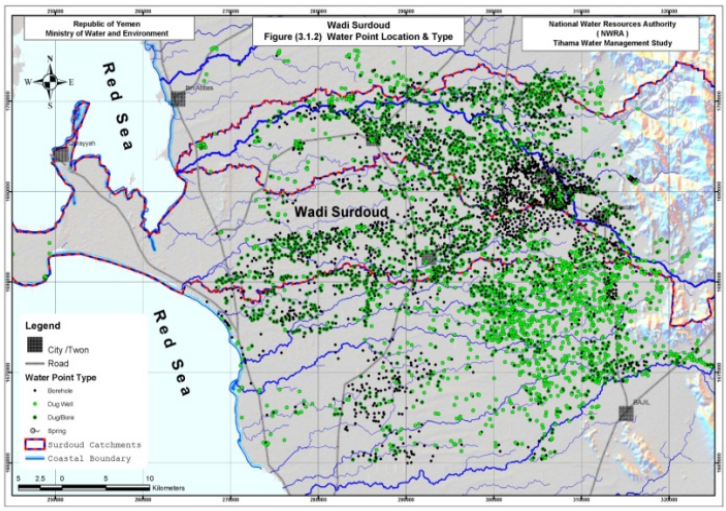


Figure (2-b): wells anatomy in Wadi Surdud

Figure (2-b) shows wide number of drilled wells as black dots in Wadi Surdud. The highest number of drilled wells concentrated at the east region of the Wadi, while it decreased in number towards the middle, to only few number at the western region. About 20,000 wells had been drilled during the period from 2003 to 2009; in six years only with an average augmentation of 3333 wells each year. Well drilling in Yemen is done by 381 drilling companies and 656 drilling rigs. This simultaneous rising rate of 6% in quantity number of drilled wells yearly form a serious problem for groundwater future and considered as a fundamental threat to the wellbeing of the Yemeni people. Yemen groundwater class leveled had took place among the top 20 groundwater – abstracting countries (IWMI, 2007) as it shown in figure (3) marked by a red column which reflect a serious alert status of uncontrolled overdraft.

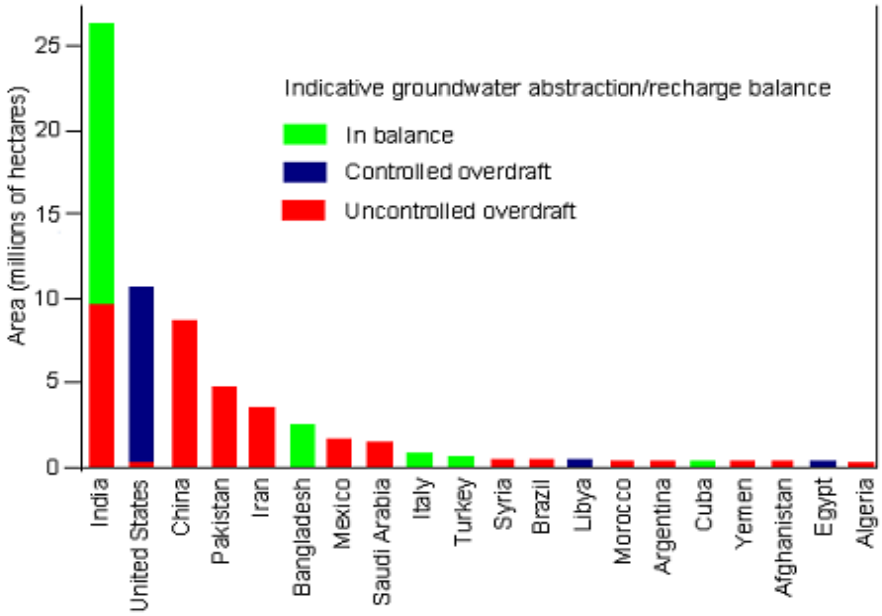


Figure (3): Top 20 groundwater-abstracting countries

- Overview of Yemen's Agriculture Sector

Agriculture sector in Yemen is characterized by a few distinct features, namely its diversification, strong market orientation and the dependence on irrigation, particularly from groundwater. Although most of the area of Yemen is a hyper-arid desert, the climate of the remaining parts varies at large. The country can be classified into three distinguished agro-ecological zones. The principal crops in these zones are shown in Table (2). It should be noted that some of the crops are completely rain fed in some areas, while are partially irrigated with pumped water in other areas. In general, vegetables and fruits are irrigated crops.

Table (2): Principal crops in different agro-ecological zones of Yemen

Principal crops	Mani agricultural governorates	agro-ecological zone
Millet, sorghum, tomatoes, onion, bananas, oranges, cotton, sesame	Hodeida, Lahj, Abyan	Coastal
Maize, millet, sorghum, wheat, grapes, tomatoes, potatoes, onion, cow peas, qat, coffee, alfalfa.	Sana'a, Hajjah, Sa,adah, Mahwit, Dhamar, Ibb, Taiz, Al-beida	Highlands
Sorghum, wheat, dates, tomatoes, potatoes, onion, alfalfa	Ma'areb, Hadramawt, Al-jawf, Shabwa	Eastern plateau

Source:

An outlook of crop diversity and agriculture production during the years 2007, 2008, and 2009 (Table) indicates that that fodder and cereals crops constitute the largest share of crop production. However, there is a decreasing trend in cereals crops production as these crops are less competitive and Yemen is now heavily dependent on imported cereals. On the other side, the production of higher value cash crops, which are mostly irrigated, has increased enormously, and Yemen is largely self-sufficient in fruit and vegetables (Fig.). Among vegetables crops, potatoes record the highest production of 278002 ton in 2009, where sweet melons has the lowest value of 31598 ton. Within cash crops the highest production goes to cotton, where the lowest goes to coffee (24895 and 18924 ton respectively). Concerning fruits crops mango has the highest production of 404573 ton and papayas recorded the lowest yield with 25117 ton.

Table (3): Agricultural Crops Production (ton): 2007 – 2009

Year	2009	2008	2007
Cereal	674,488	713,739	940,832
Wheat	222,129	170,446	218,520
Maize	56,087	65,813	86,596
Sorghum	311,504	376,728	502,304
Millet	61,527	74,048	98,731
Barley	23,241	26,704	34,681
Legumes	81,822	90,271	94,937
Broad beans	7,264	7,112	6,905
Dry beans	3,602	3,573	3,469
Peanuts	1,685	1,647	1,599
Other legumes	69,271	77,939	82,964
Vegetables	1,090,479	1,037,246	995,386
Tomatoes	251,269	239,897	232,910
Onions	215,500	202,761	191,284
Potatoes	278,022	263,945	249,005
Sweet-melons	31,598	30,290	29,696
Water-melons	172,148	165,520	162,274
Other Vegetables	141,942	134,833	130,217
Fodder	2,119,908	2,000,368	1,870,948
Alfalfa	300,909	290,370	284,119
Other fodders	1,818,999	1,709,998	1,586,829
Cash crops	90,681	88,852	86,376
Cotton	24,895	24,115	23,322
Sesame	24,285	23,895	23,312
Tobacco	22,577	22,054	21,412
Coffee	18,924	18,788	18,330
Fruits	988,679	958,977	922,441
Dates	56,760	55,204	53,596
Bananas	132,418	128,796	120,370
Grapes	129,385	127,132	125,811
Orange & Mandarins	134,718	131,241	129,098
Papayas	25,117	24,481	23,404

Mangoes	404,573	387,906	369,434
Other fruits	105,708	104,217	100,728
Qat	173,856	165,668	156,290
Grand Total	5,219,913	5,055,121	5,067,210

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

Verification of table (3) shows agriculture crops area from 2007 to 2009 indicates that cereals crops occupied the biggest area of 677725 acre in 2009 but it - is in the same time - the lowest area comparing with precedent two years 2008, and 2007 (760189 and 890612 acre respectively). In paradox, qat area increased from 141163 acre in 2007 to reach 153512 acre in 2009. At least legumes record the lowest occupied area of 43716 acre during 2009. In general the total crops area had been decreased from 1482442 acre in 2007 to 1306776 acre in 2009.

Cultivated area by source of irrigation; wells, rainfall, floods, dams, springs, tankers, or any other as shown in table (4). The table indicates that Ibb has the biggest no of holders, but Hodeidah is the biggest governorate in cultivated area under whatever source of irrigation, in the other hand Aden records the lowest cultivated area for any source of irrigation. It can be deduced from the Table (4) that well irrigation is responsible for about 65 percent of total irrigated lands.

Table (4): Cultivated area by source of irrigation

Governorate	Crops Area	Cultivated Area by Source of Irrigation							No. of Holders
		Wells	Rainfall	Floods	Dams	Springs	Tankers	Others	
Ibb	75,848	21,237	35,649	13,653	2,351	1,972	910	76	177,614
Abyan	52,430	14,680	24,642	9,437	1,625	1,363	629	54	28,449
Sana'a City	7,057	1,976	3,317	1,270	219	184	85	6	7,725
Al-Baida	33,492	9,378	15,741	6,029	1,038	871	402	33	34,778
Taiz	75,708	21,198	35,583	13,627	2,347	1,968	909	76	155,505
A-Jawf	51,142	14,320	24,037	9,206	1,585	1,330	614	50	28,638
Hajjah	119,477	33,454	56,154	21,506	3,704	3,106	1,434	119	98,292
Al-Hodeidah	295,757	82,812	139,006	53,236	9,168	7,690	3,549	296	87,486

Hadramout	**45,369**	**12,703**	**21,323**	**8,166**	**1,406**	**1,180**	**544**	**47**	**40,159**
Dhamar	**103,347**	**28,937**	**48,573**	**18,603**	**3,204**	**2,687**	**1,240**	**103**	**111,969**
Shabwah	**25,269**	**7,075**	**11,876**	**4,548**	**783**	**657**	**305**	**25**	**22,578**
Sa'adah	**40,995**	**11,479**	**19,268**	**7,379**	**1,271**	**1,066**	**492**	**40**	**49,113**
Sana'a	**152,924**	**42,819**	**71,874**	**27,526**	**4,741**	**3,976**	**1,835**	**153**	**88,905**
Aden	**1,630**	**456**	**766**	**293**	**51**	**42**	**20**	**2**	**516**
Laheg	**32,168**	**9,007**	**15,119**	**5,790**	**997**	**836**	**386**	**33**	**55,570**
Mareb	**39,922**	**11,178**	**18,763**	**7,186**	**1,238**	**1,038**	**479**	**40**	**14,450**
Al-Mahweet	**25,811**	**7,227**	**12,131**	**4,646**	**800**	**671**	**310**	**26**	**44,698**
Al-Maharah	**2,946**	**825**	**1,385**	**530**	**91**	**77**	**35**	**3**	**3,467**
Amran	**89,310**	**25,007**	**41,976**	**16,076**	**2,769**	**2,322**	**1,072**	**88**	**69,395**
Al-Daleh	**13,514**	**3,784**	**6,352**	**2,433**	**419**	**351**	**162**	**13**	**36,680**
Reymah	**22,660**	**6,345**	**10,650**	**4,079**	**702**	**589**	**272**	**23**	**35,994**
Total	**1,306,776**	**365,897**	**614,185**	**235,219**	**40,509**	**33,976**	**15,684**	**1,306**	**1,191,981**

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

Most of the land under irrigation is planted with qat, followed by cereals and vegetables. Table shows also that qat production had been increased from 156290 ton in 2007 to reach 173856 ton in 2009. Qat cultivation has spread to cover one tenth of prime land.

Verification of table (5) shows agriculture crops area from 2007 to 2009 indicates that cereals crops occupied the biggest area of 677725 acre in 2009 but it - is in the same time - the lowest area comparing with precedent two years 2008, and 2007 (760189 and 890612 acre respectively). In paradox, qat area increased from 141163 acre in 2007 to reach 153512 acre in 2009. At least legumes record the lowest occupied area of 43716 acre during 2009. In general the total crops area had been decreased from 1482442 acre in 2007 to 1306776 acre in 2009.

Table (5): Agricultural Crops Area (acre): 2007-2009

Year	2009	2008	2007
Cereals	677,725	760,189	890,612
Wheat	117,525	123,103	141,498
Maize	37,402	43,647	51,961
Sorghum	392,780	442,819	520,963
Millet	97,688	113,294	133,287
Barley	32,330	37,326	42,903
Legumes	43,716	47,691	50,333
Broad beans	4,131	4,112	4,031
Dry beans	1,375	1,368	1,341
Peanuts	2,427	2,354	2,308
Other legumes	35,783	39,857	42,653
Vegetables	88,990	84,854	82,103
Tomatoes	18,071	17,273	16,934
Onions	14,851	14,072	13,402
Potatoes	21,497	20,310	19,343
Sweet-melons	3,102	3,004	2,945
Water-melons	13,364	12,880	12,628
Other vegetables	18,105	17,315	16,851
Fodder	163,002	155,762	147,007
Alfalfa	26,572	25,754	25,249
Other fodders	136,430	130,008	121,758
Cash Crops	86,943	85,550	83,443
Cotton	19,664	19,096	18,504
Sesame	22,613	22,212	21,776
Tobacco	10,169	9,950	9,642
Coffee	34,497	34,292	33,521
Fruits	92,888	90,719	87,781
Dates	14,764	14,465	14,180
Bananas	10,264	10,005	9,529
Grapes	13,488	13,178	12,920
Orange & Mandarin	9,754	9,566	9,256
Papayas	1,512	1,484	1,434
Mangoes	25,818	25,095	24,130
Other fruits	17,288	16,926	16,332
Qat	153,512	146,810	141,163
Grand Total	1,306,776	1,371,575	1,482,442

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

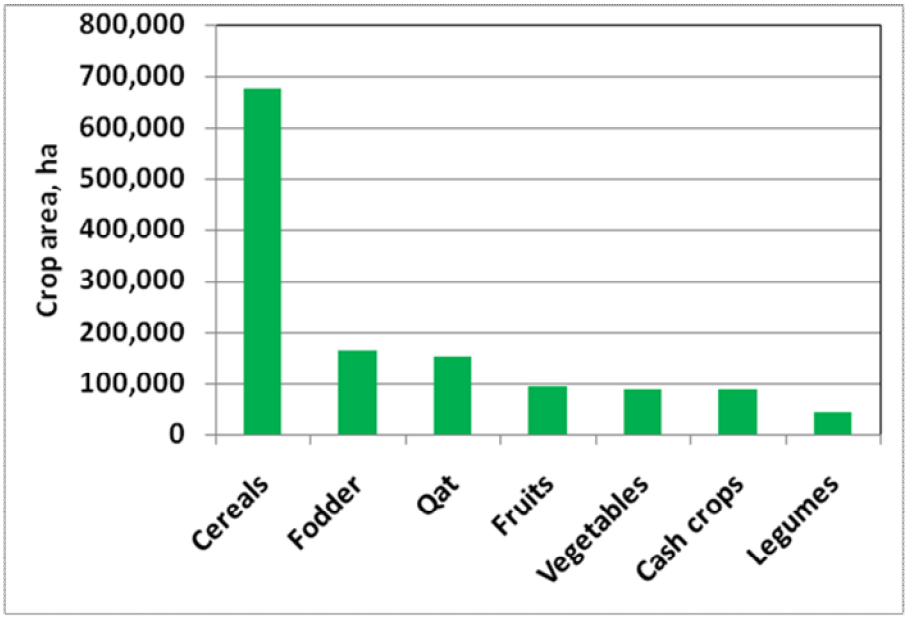
Where comparing between crops production and crops area resulted crops productivity (ton/acre). As table (6) shows, productivity of fodder crops have the highest value of 13.01 ton/acre. Where the lowest productivity value is for cereals crops (1.00). Results of crops productivity indicates that increasing in qat production from 2007 to 2009 is due to increasing of its occupied area because qat productivity of 1.13 tons/acre considered low.

Table (6): Crop production vs. crop area 2009

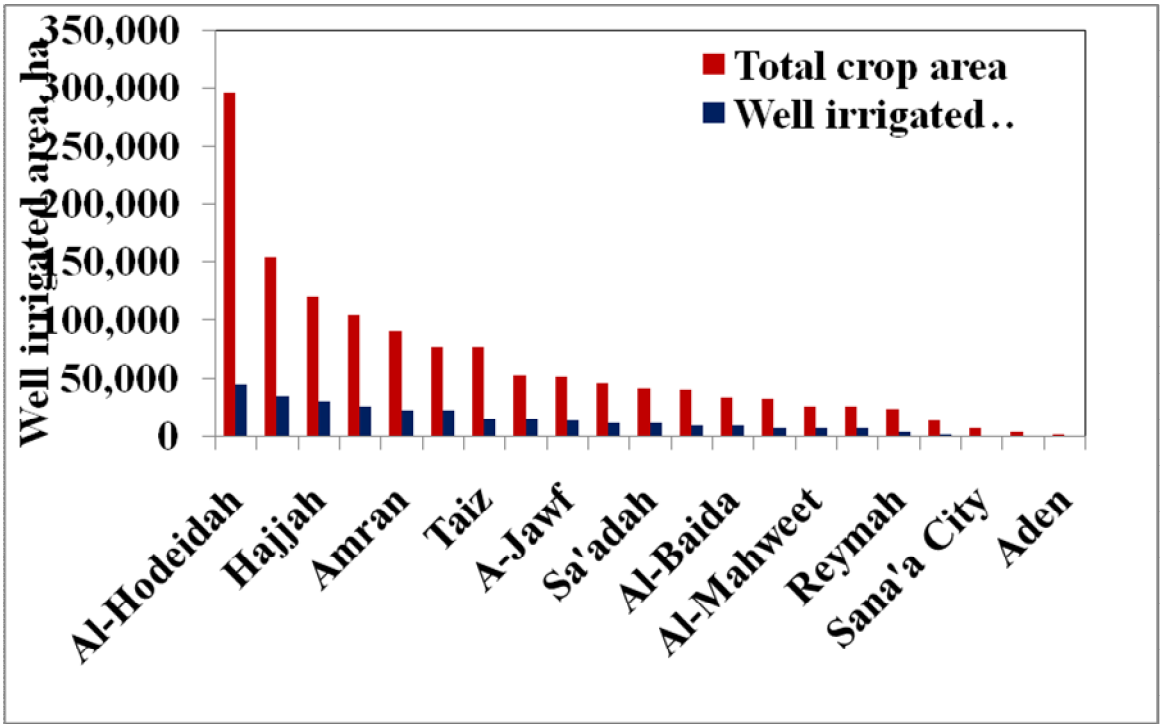
Crop	Production (ton)	Area (acre)	Productivity (ton/acre)
Cereal	674,488	677,725	1.00
Wheat	222,129	117,525	1.89
Maize	56,087	37,402	1.50
Sorghum	311,504	392,780	0.79
Millet	61,527	97,688	0.63
Barley	23,241	32,330	0.72
Legumes	81,822	43,716	1.87
Broad beans	7,264	4,131	1.76
Dry beans	3,602	1,375	2.62
Peanuts	1,685	2,427	0.69
Other legumes	69,271	35,783	1.94
Vegetables	1,090,479	88,990	12.25
Tomatoes	251,269	18,071	13.90
Onions	215,500	14,851	14.51
Potatoes	278,022	21,497	12.93
Sweet-melons	31,598	3,102	10.19
Water-melons	172,148	13,364	12.88
Other Vegetables	141,942	18,105	7.84
Fodder	2,119,908	163,002	13.01
Alfalfa	300,909	26,572	11.32
Other fodders	1,818,999	136,430	13.33
Cash crops	90,681	86,943	1.04
Cotton	24,895	19,664	1.27
Sesame	24,285	22,613	1.07
Tobacco	22,577	10,169	2.22
Coffee	18,924	34,497	0.55

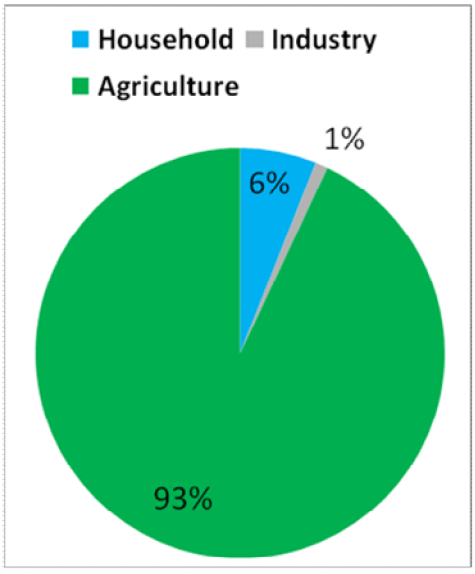
Fruits	**988,679**	**92,888**	**10.64**
Dates	**56,760**	**14,764**	**3.84**
Bananas	**132,418**	**10,264**	**12.90**
Grapes	**129,385**	**13,488**	**9.59**
Orange & Mandarins	**134,718**	**9,754**	**13.81**
Papayas	**25,117**	**1,512**	**16.61**
Mangoes	**404,573**	**25,818**	**15.67**
Other fruits	**105,708**	**17,288**	**6.11**
Qat	**173,856**	**153,512**	**1.13**
Grand Total	**5,219,913**	**1,306,776**	**3.99**

Source: General Division of Agriculture Statistics in the Ministry of Agriculture and Irrigation

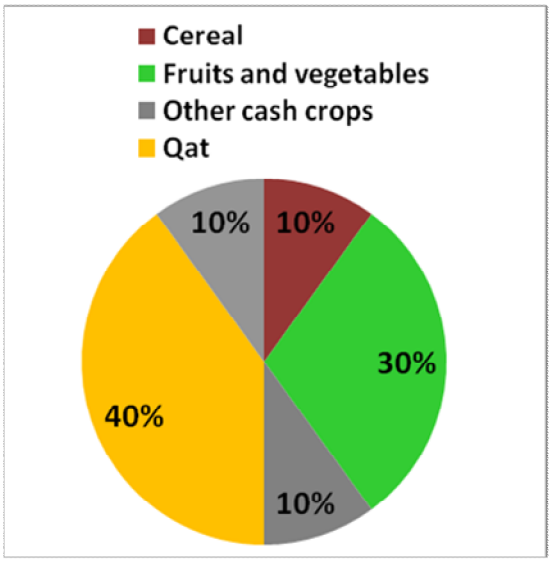


Data Source: General Division of Agriculture Statistics, MAI



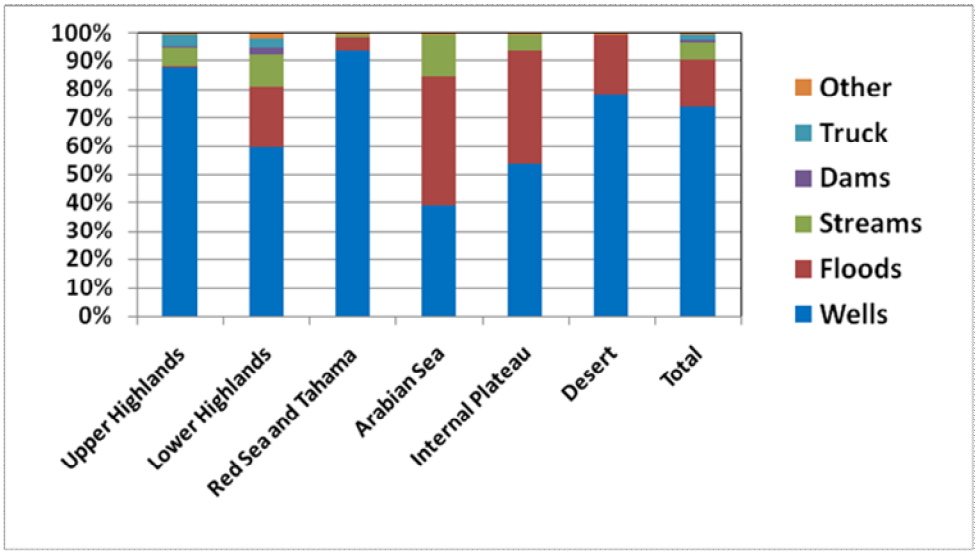


Water consumption by sector



Water consumption within agriculture

Source: MOPIC, 2010, National Food Security Strategy Paper (NFSSP)- PART II, Policies, Investments, and Program Options for Achieving Yemen's Food Security Goals



Source: MOPIC, 2010, National Food Security Strategy Paper (NFSSP)- PART II, Policies, Investments, and Program Options for Achieving Yemen's Food Security Goals

- The Burden of Diesel Subsidy

Yemen is among the countries with the lowest fuel-pump prices in the world. There are only a few other countries in the world with lower fuel prices than Yemen, among them Libya, Saudi Arabia, Bahrain, Qatar, and Kuwait, which all have a significantly higher per capita income and higher oil or gas reserves per capita (Breisinger et al., 2011).

Petroleum subsidies in Yemen make up more than 20 percent of the government budget, more than total spending on education, health and social transfers in 2007 combined. The share of the subsidy has increased dramatically over the past years, up from about 45 percent of total economic affairs expenditures in 1999 to 85 percent in 2007. This expansion of cost for the petroleum subsidy comes at the expense of other sectors. For example, fiscal resources for social protection remained fairly low, only 0.2 percent of total government spending was used for social protection and programs. (Breisinger et al., 2011). The diesel subsidy not only drains government revenue but also distorts commodity prices, and makes water pumping and trucking costs artificially low, thereby giving farmers no incentive to conserve water. (The congressional research service report, *2009)*

The largest share of fuel subsidies goes to diesel, which made up more than two-thirds of all subsidized fuels in 2009 as it appear in tables (7 and 8); 69 percent of fuel subsidies goes to diesel; 14 percent goes to gasoline; and the remainder is split between LPG, kerosene, and jet fuel.

Table (7) Distribution of the Government Budget on different sectors and the share of petroleum subsidy

2009		2008		2007		Sector
in % of total expenditures	in bill. YR	in % of total expenditures	in bill. YR	in % of total expenditure	In bill. YR	
27.5	483.0	37.1	827.2	27.3	473.5	Economic Affairs
0.2	3.0	0.1	2.7	0.1	2.4	Industry/Trade
0.2	4.4	0.1	2.6	0.2	3.2	Trans./Comm.
0.8	14.2	0.9	19.9	1.0	17.6	Agriculture/Fishing
22.2	391.0	34.1	759.3	23.2	401.7	Petroleum Subsidy
4.0	70.5	1.9	42.7	2.8	48.6	Other Econ. Affairs
3.5	61.5	3.2	70.2	3.4	59.3	Health
16.3	286.2	13.1	291.7	14.5	251.1	Education
2.7	47.8	0.2	5.1	0.2	4.2	Social Protection
18.2	320.5	20.3	452.9	24.0	416.5	General Public Services
16.4	288.2	13.3	297.1	15.7	272.8	Defense
15.4	270.3	12.7	283.2	14.8	256.3	Other
100.0	**1,757.6**	100.0	**2,227.5**	**100.0**	**1,733.8**	**Total**

Source: Ministry of Finance (2010)

Table (8) Subsidy of diesel fuel

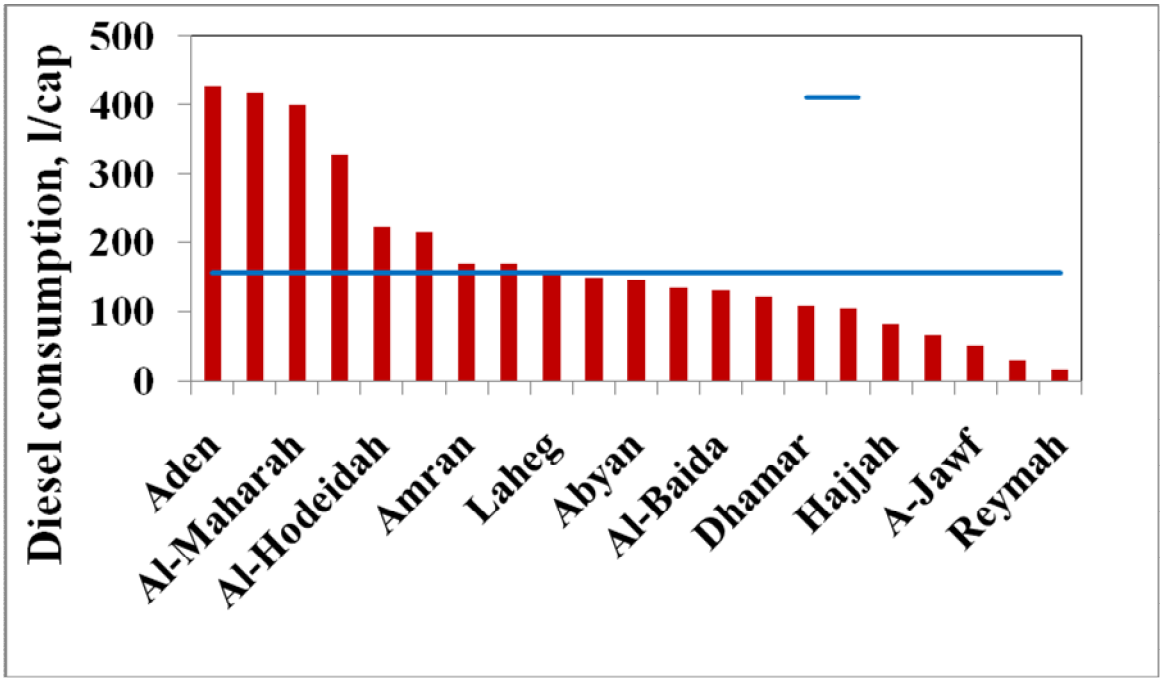
2010 Q2	**2010 Q1**	**2009**	**Subsidy Type**
65	63	69	Share in total subsidy (percent)
74	32	17	Domestic price (PEC & large users)
41	38	35	Domestic subsidized price (small users)
134	123	158	Price at the Yemen border (incl. tax, freight, and so on)
95	90	264	Total annual diesel subsidy (in billion YER)

Sources: Yemen, Ministry of Finance (2010), IMF (2010), and World Bank (2010).

- Who is Benefiting from Diesel Subsidies?

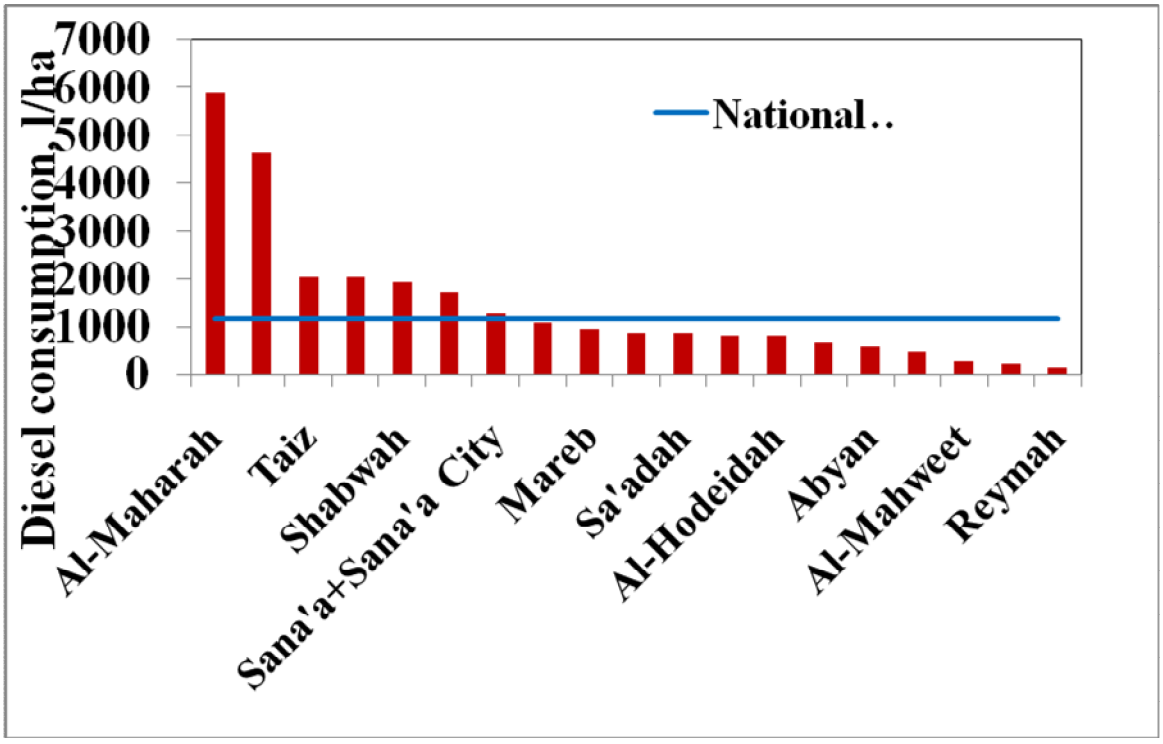
Case I: Diesel smugglers:

Diesel smuggling hypothesis: very high per capita use in Aden, Alhodeidah and Eastern Governorates which are open to sea indicates large scale smuggling



Diesel use per capita by Governorates for 2010

Diesel smuggling hypothesis: very high per ha use in Aden and Eastern Governorates which are open to sea indicates large scale smuggling

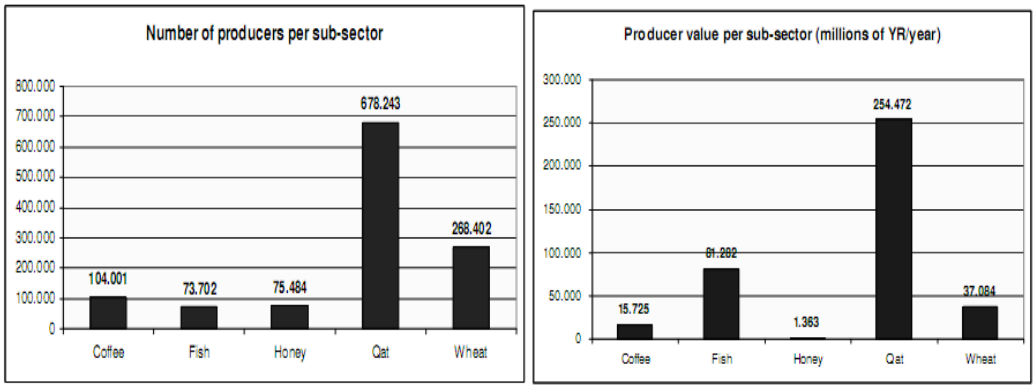


Diesel use per irrigated area (ha) by Governorates for 2010 (assuming diesel use in agriculture @ 12.4 of total consumption)

Case II: Qat big farmers

Qat annual turnover: 254.472 Billion YR (10% GDP, one third of agricultural GDP)

Average yearly income of qat farmer: 375,000 YR (more than twice per capita income)
Qat profitability: 5 times as profitable as grapes and 20 times as profitable as potatoes



Source: World Bank, 2009, Analysis of 5 value chains – Yemen (Fish, Honey, Coffee, Wheat and Qat)

- Chronicle of Diesel Crisis in Yemen
- Diesel Crises and Its Causes

Over the last years Yemen witnesses diesel crisis several times with varying degrees severity. The crisis that occurred in August-September 2008, which was one of the worst crises, came in awake of an unexpected decision of the Yemeni government to increase diesel prices for some sectors from YR35 to YR 200 per liter, five times more than the previous price. These sectors include steel, electricity and cement plants. The decision has pressed owners of diesel-fueled businesses including bakeries and laundries, as well as small factories to rush to diesel stations to buy more quantities of diesel to keep in storage, fearing it might become unavailable on the market soon. In a letter directed to the government, Commerce and Industry Chambers Union warned that the decision is dangerous and poses threats to the industry in Yemen, stressing it will affect the future flow of investment into the country (*Al-Omari 2008*).

In the years 2009 and 2010 Yemen had also seen two diesel crises. In 10th of June 2009 the Government announced new distribution regulations for diesel fuel based on the actual consumption and the geographical distribution of population (Yemen economic website). Subsequently, diesel crisis occurred. In 13th of July 2010, diesel crisis erupted few days after raising diesel price. Armed groups in Saber region, Lahj governorate, protesting against the diesel shortage in their local villages, captured a number of fuel trucks on the main road leading to the heartland from the port city of Aden (Alwatan.net website).

However, Yemen has never seen fuel crisis as that started in March 2011 and didn't

end until now. This complicated crisis came in the wake of dire political unrest in the country which stroke Yemen in the aftermath of the Arab spring since the beginning of 2011.

The fuel crisis of 2011 was not limited to only diesel. The crisis was for all fuel types, cooking gas (LNG),and electricity. It has affected all sectors and public in large: farmers, vehicles, truck drivers depend mainly on diesel to run their daily businesses. Moreover, houses and restaurants rely on gas and would be affected by the shortages of gas. Arrabyee described the situation “citizens have been subjected to blackmailing and manipulation in the prices of gas". " The government attributed diesel and gas shortages to a blockage of roads and seizing gas and diesel trucks by some tribes in Mareb, east of Yemen” however, “tribal sources denied the relation of Mareb tribes with gas and diesel crisis"(newspaper,). Craig wrote in an article in the Gulf Business News and Analysis “With cooking gas shortages, a diesel crisis and many parts of the capital being restricted to no more than four hours a day of electricity, patience is beginning to run out. For Yemenis the impact of the unrest has affected every aspect of their lives. Added to the power and fuel shortages, the price of wheat has risen by 45 per cent, and the cost of rice by 22 per cent, according to the World Food Programme". (web site of gulf business news and analysis)

The obvious reason for crisis was the cease of crude oil flow from Mareb oil production fields to Aden Refinery from where fuel products were distributed for domestic consumption. The Government blamed the opposition supporters. i.e. Joint Meeting Parties (JMP), of bombing oil pipes and blocking gas and fuel tankers from reaching to the different provinces whereas the JMP has been blaming the government of creating the crisis for paralyzing the normal live of the people.

In general the circle of diesel crises excluding the crisis of 2011 can be attributed to several reasons:

- Marketing management faults on the side of the National Oil Company such as: delayed arrival of diesel tankers imports.
- Diesel smuggling to neighboring countries which is believed to be a key reason for the constant diesel crisis. (estimates of smuggled quantities). The government revealed that diesel smuggling inflicts big losses on the country, especially when the subsidized diesel does not reach those people who are in urgent need for it.
- Fluctuations in demand in different times of the year, e.g. there is more demand on gas and diesel on the advent of the month of Ramadan, the holy month for fasting. The people resort to storing big quantities of gas and diesel fearing a possible crisis through the month or during Eid holiday. Also farmers, bakery owners and small factories owners buy diesel in big quantities for storage purposes.
- Occurrence of technical faults in national refineries which cause lower production capacity of plants.

Fuel crisis has turned deadly on the people. People have to pay high to get oil. The

report mentioned that power shortages also loom over the country as some patients even lost their lives due to constant blackout (*CNC* website, *22 June 2011*).

- Importance of Petroleum Subsidies for Yemen

22 January 2009, in the congressional research service report titled: "*Yemen, Background and U. S. Relations*" said: "The diesel subsidy not only drains government revenue but also distorts commodity prices, and makes water pumping and trucking costs artificially low, thereby giving farmers no incentive to conserve water.

March 2011, in the *International Food Policy Research Institute (IFPRI)* discussion paper about *Petroleum Subsidies in Yemen*: "As Yemen is considered as one of the poorest Arabic country with the lowest per capita income. It is well appear that petroleum subsidies are the public finances and fostering sustainable economic development and provide only a blunt tool in the fight against poverty.

Yemen faces a number of challenges: slow non-hydrocarbon growth, little economic diversification, high population growth, decreasing oil production, unsustainable use of water resources, and high levels of poverty and food insecurity.

Yemeni economy is dominated by the hydrocarbon sector (oil) and non-tradable services, while manufacturing and export-oriented services make up a relatively small share of the economy. Agriculture contributes about 10 percent to GDP, and 30 percent of the Yemeni population earn their livelihood from farming. However, 70 percent of the population lives in rural areas, and 34.8 percent of Yemenis live below the poverty line in 2005/6 (WB 2007).

Table (1): Role of petroleum subsidy in the government budget 2007 - 2009

Year	2007		2008		2009	
Sector	In bill. YR	in % of total expenditures	In bill. YR	in % of total expenditures	In bill. YR	in % of total expenditures
Economic Affairs	473.5	27.3	827.2	37.1	483.0	27.5
Industry/Trade	2.4	0.1	2.7	0.1	3.0	0.2
Trans./Comm.	3.2	0.2	2.6	0.1	4.4	0.2
Agriculture/Fishing	17.6	1.0	19.9	0.9	14.2	0.8
Petroleum Subsidy	401.7	23.2	759.3	34.1	391.0	22.2

Other Econ. Affairs	48.6	2.8	42.7	1.9	70.5	4.0
Health	59.3	3.4	70.2	3.2	61.5	3.5
Education	251.1	14.5	291.7	13.1	286.2	16.3
Social Protection	4.2	0.2	5.1	0.2	47.8	2.7
General Public Services	416.5	24.0	452.9	20.3	320.5	18.2
Defense	272.8	15.7	297.1	13.3	288.2	16.4
Other	256.3	14.8	283.2	12.7	270.3	15.4
Total	**1,733.8**	**100.0**	**2,227.5**	100.0	**1,757.6**	100.0

Source: Yemen, Ministry of Finance (2010)

Table (2): Subsidy by type of fuel

Subsidy Type	2009	2010 Q1	2010 Q2
Diesel			
Share in total subsidy (percent)	69	63	65
Domestic price (PEC & large users)	17	32	74
Domestic subsidized price (small users)	35	38	41
Price at the Yemen border (incl. tax, freight, and so on)	158	123	134
Total annual diesel subsidy (in billion YER)	264	90	95
Gasoline			
Share in total subsidy	14	22	23
Domestic price	60	63	68
Price at the Yemen border (incl. tax, freight, and so on)	87	121	130
Total annual gasoline subsidy (in billion YER)	55	31	33
Total subsidy reduction (savings) YER/liter	0	3	5
LPG			
Share in total subsidy	11	12	8

Domestic price in YER/liter	23	30	42
Price at the Yemen border (incl. tax, freight, and so on)	52	70	64
Total annual LPG subsidy (in billion YER)	41	17	11
Total subsidy reduction (savings) YER/liter	0	7	11
Kerosene			
Share in total subsidy	4	1	2
Domestic price	36	38	41
Price at the Yemen border (incl. tax, freight, and so on)	112	121	134
Total annual kerosene subsidy (in billion YER)	15	1	3
Total subsidy reduction (savings) YER/liter	0	2	3
Jet fuel			
Share in total subsidy	2	2	2
Domestic price	36	39	43
Price at the Yemen border (incl. tax, freight, and so on)	97	123	136
Subsidy in billion Ryals	9	3	4
Subsidy as percentage of import prices	68	69	68
Total fuel subsidy in billion Ryals	385	142	146

Sources: Yemen, Ministry of Finance (2010), IMF (2010), and World Bank (2010).

The largest share of fuel subsidies goes to diesel, which made up more than two-thirds of all subsidized fuels in 2009, as indicated in table (2): 69 percent of fuel subsidies go to diesel; 14 percent goes to gasoline; and the remainder is split between LPG, kerosene, and jet fuel.

In terms of total domestic fuel consumption, diesel accounted for the largest part, with 3.96 billion liters in 2009, followed by gasoline (2.04 billion), jet fuel (1.34 billion), and kerosene (0.12 billion).

Table (3): Role of fuel products in the economy

Sector	Share in total fuel consumption	Fuel intensity in **production/ consumption**	Fuel import **intensity by sector**
Agriculture	12.4	19.6	49.8
Fuel products	0.5	7.0	184.6
Industry	29.9	11.6	34.7
Transport	40.0	30.8	—
Other services	7.1	2.3	—
Households	10.1	1.2	—
Urban	*37.1*	*1.1*	—
Rural	*62.9*	*1.2*	—

Source: Based on HBS (2005/2006) and the Social Accounting Matrix of 2009.

Most of the fuel is consumed as intermediate inputs in agriculture, industry, and services. About 40 percent of all fuel is used for transportation (Table 3), followed by the mining sector (mainly oil production) and industries.

Agriculture consumes about 12 percent of all fuel, mostly for irrigation. Interestingly, fuel is the single largest expenditure item for agricultural production despite the petroleum subsidy. The transport sector as the biggest consumer of fuel constitutes also an important input for the production of other sectors; industry and services are the most transportation-intensive sectors, with transportation making up 14 and 8 percent of their output, respectively. Moreover households consume about 10 percent of all fuel products

Table (4): The share of fuel products in household consumption

Household consumption	Total	Urban	Rural
Fuel products			
Per capita expenditure (YER/year)	1,805	2,659	1,363
Share in total expenditure	1.2	1.1	1.2
Transport			
Per capita expenditure (YER/year)	13,281	46,130	6,677
Share in total expenditure	8.5	12.9	5.8
Fuel plus transport			
Per capita expenditure (YER/year)	15,086	48,790	8,040
Share in total expenditure	9.7	14.0	7.0

Source: Based on HBS (2005/2006) and SAM (2009).

In conclusion Yemen is among the countries with the lowest fuel-pump prices in the world. The petroleum subsidy makes up 85 percent of all public spending related to economic affairs and is more than the total spending on health, education, and social protection combined. Especially social transfers and investments in infrastructure.

- Diesel and Groundwater Pumping Nexus

July 2001, Christopher Ward in The British-Yemeni Society report about Yemen's water crisis: The government has lacked the technical means, the legal instruments, and the political will to regulate the sinking of wells and groundwater extraction. At the same time it pursued policies which actively encouraged water use: low-interest loans, cheap diesel pricing, and public investment in surface or spate irrigation. As a result, over the past two decades, groundwater and surface irrigation have been priced at well below their economic cost. A government ban on the import of fruit and vegetables gave further impetus to groundwater development by making local cultivation of such produce far more profitable. Finally, the government's supportive attitude towards the booming production and use of *qat,* the country's most profitable cash crop, has accelerated trends towards over pumping: *qat* is estimated to consume 30% of all irrigation water, and its cultivation has been encouraged by a government ban on imports of cheaper Ethiopian *qat.*

However, after 20 years of holding down irrigation water prices, the government is now increasing them. Groundwater prices have been affected as the price of diesel shot up between 1996-1999 from the equivalent of $0. 02 to $0. 10 per liter; it is set to rise further by 2001 to about $0. 16 per liter. Meanwhile, the supply of cheap credit has dwindled and interest rates have increased. Controls on fruit and vegetable imports are being dismantled. All these actions will bring the price of groundwater closer to its economic cost. The government is considering involving user groups in the operation and maintenance of spate irrigation schemes with a view to ultimately handing over to users' full responsibility for them.

Meanwhile, the increase in water prices resulting from the removal of diesel subsidies will encourage farmers to adopt water-efficient technologies, which will help to relieve pressure on groundwater. The transfer of responsibility to local farmers for spate irrigation systems should also provide incentives for improved husbandry and sustainability. Similarly, a policy of renewed support for traditional water control systems has the potential to increase agricultural production and boost the incomes of small farmers. Nevertheless, decentralization and the partnership approach can only be viewed as elements of a damage limitation exercise aimed at slowing the rate of resource depletion, to allow Yemen time to develop patterns of economic activity less dependent on water mining.

Groundwater for irrigation is pumped from about 50,000 private wells throughout Yemen, of which 8,000 wells are located in the Sana'a Basin alone. The driving energy for water pumps comes from diesel. The largest reported use of diesel is for agriculture: 22.1 million liters of the total of 45 million liters per month is used for this purpose.

Table shows the distribution of fuel consumption amongst economy sectors. Agriculture consumes about 12 percent of all fuel, mostly for irrigation. Most of the

fuel is consumed as intermediate inputs in agriculture, industry, and services. About 40 percent of all fuel is used for transportation, followed by the mining sector (mainly oil production) and industries. In terms of total domestic fuel consumption, diesel accounted for the largest part, with 3.96 billion liters, followed by gasoline (2.04 billion), jet fuel (1.34 billion), and kerosene (0.12 billion).

Distribution of fuel consumption amongst economy sectors

12.4	Agriculture
40.0	Transport
29.9	Industry
0.5	Fuel products
7.1	Other services
10.1	Households

Source: Breisinger et al., 2011

It is well known that groundwater mining is not only unsustainable, it is also inequitable. If groundwater mining is correlated with diesel use it could be seen that better off farmers have captured the lion's share of groundwater. Besides, due to falling water tables, shallow groundwater and springs available to poorer farmers have been depleted or exhausted. Breisinger et al. (2011) have shown that the use of diesel for agriculture is highly concentrated in the two top income deciles: for example, in rural areas, 29.8% of households in the top decile report diesel use for agriculture (and who use 200 liters a month for this purpose), as opposed to only 1.7% of rural households in the poorest decile (who use only 25 liters a month).

Prior to the year 1996, the Government pursued policies which actively encouraged water use: low-interest loans, cheap diesel pricing, and public investment in surface or spate irrigation. As a result, groundwater irrigation has been flourished in wasteful mean. Groundwater use began to exceed recharge in the mid-1980's with more than 80% of abstraction going to irrigated agriculture (half of which is for qat in some areas). A government ban on the import of fruit and vegetables gave further impetus to groundwater development by making local cultivation of such produce far more profitable. Finally, the government's unresponsive (even supportive) attitude towards the booming production and use of *qat,* the country's most profitable cash crop, has accelerated trends towards overpumping: *qat* is estimated to consume 30% of all irrigation water. Most of the land under irrigation is planted with qat, followed by cereals and vegetables. In addition, cheap fuel has also encouraged traders to extract water and transport it to distant regions, often to irrigate qat plantations. Water transported by truck is used on 2.3 percent of the total irrigated land.

However, after the year 1996 gradual changes in the policies have been introduced. Groundwater prices have been affected as the price of diesel shot up between 1996

and 2010. Meanwhile, the supply of cheap credit has dwindled and interest rates have increased. Controls on fruit and vegetable imports are being dismantled. All these actions increased the cost of water pumping.

Many experts believe that the removal of diesel subsidies will encourage farmers to adopt water-efficient technologies, which will help to relieve pressure on groundwater. In fact, even before subsidy reduction, fuel is the most expensive item in crop production, as nearly one-third of crop production expenditure is used for fuel purchase.

Diesel consumption in governorates depends on many factors. The most important factors include number of vehicles, industrial production, well irrigated area and population.

- Diesel as Energy Source for Water Pumping

More abstraction of groundwater for irrigation more depending on diesel as an energy source for pumping. Other elements help increasing in groundwater pumping exploitation:

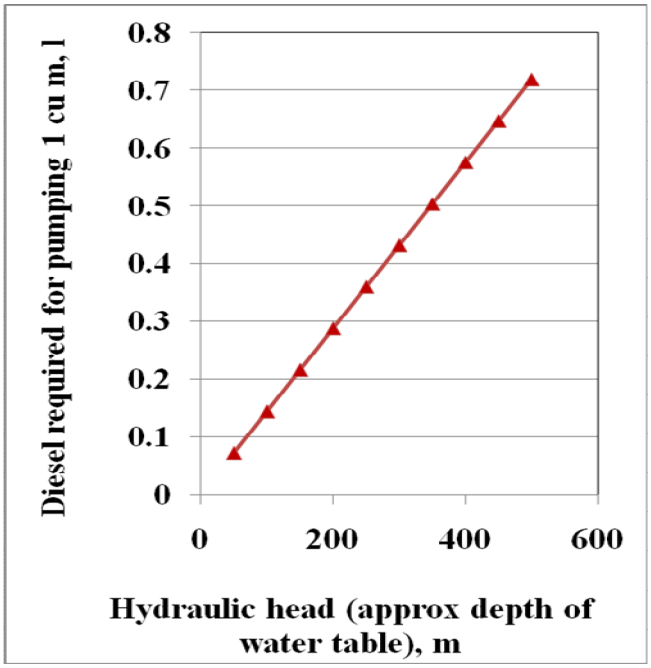
- Cheap diesel price, much less than import price, 69% of fuel subsidies goes to diesel,
- Cheap credit,
- Absence of pumping equipment duties,
- Import ban on competing cash crops,
- Absence of any regulatory framework.

Reports indicates that 22.1Million Liters of Diesel were consumed monthly for irrigation water pumping of what 30% goes to qat trees.

- Diesel Consumption for Water Pumping

$$E = \frac{9.81(1000)Qh}{\eta_p \eta_e} 10^{-6}$$

E= Energy required for pumping of water
h= Hydraulic head, m
Q= Volume of water pumped, m^3
$\acute{\eta}_e$= Efficiency of the pump
$\acute{\eta}_p$= Efficiency of the diesel engine



Taking;

- The specific energy content of diesel E_{sd}= 36.4 Mj/l
- Average diesel engine efficiency = 25%
- Average pump efficiency = 75%

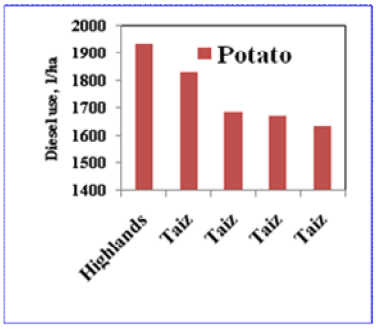
So, the quantity of diesel required for pumping as l/m^3 will be;

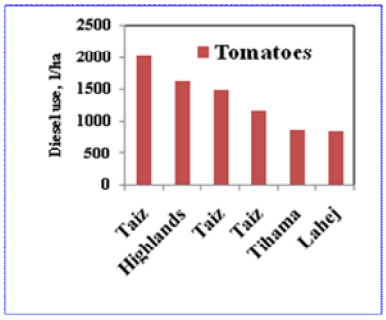
$$q = E/E_{sd}$$

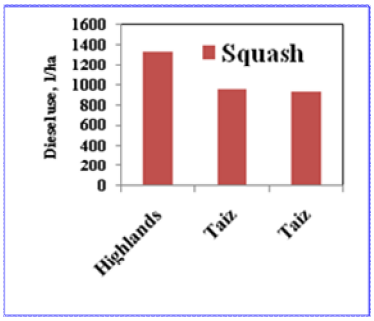
- Diesel Use for Pumping Water in Some Basins

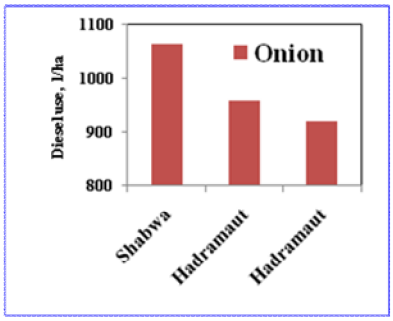
Basin	Total abstraction, MCM	Average Depth, m	Diesel use for pumping, Ml
Sana'a	**270**	**250**	**97.022**
Taiz	**62**	**150**	**13.367**
Hadramout	**400**	**100**	**57.495**
Sa'adah	**105**	**180**	**27.166**

- Diesel Consumption for Some Crops Under Surface Irrigation

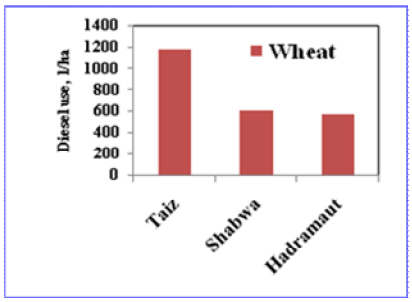


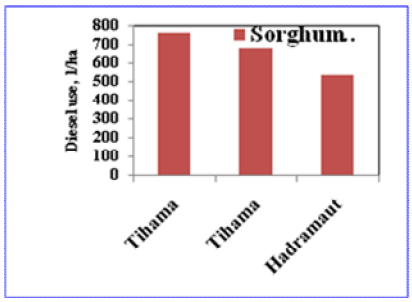


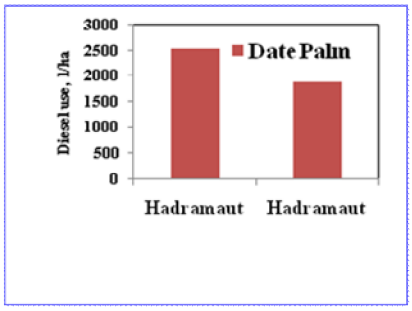


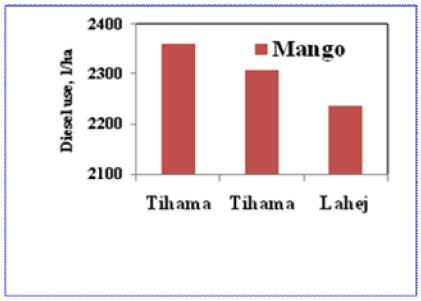


Data Source: GSCP, 2011



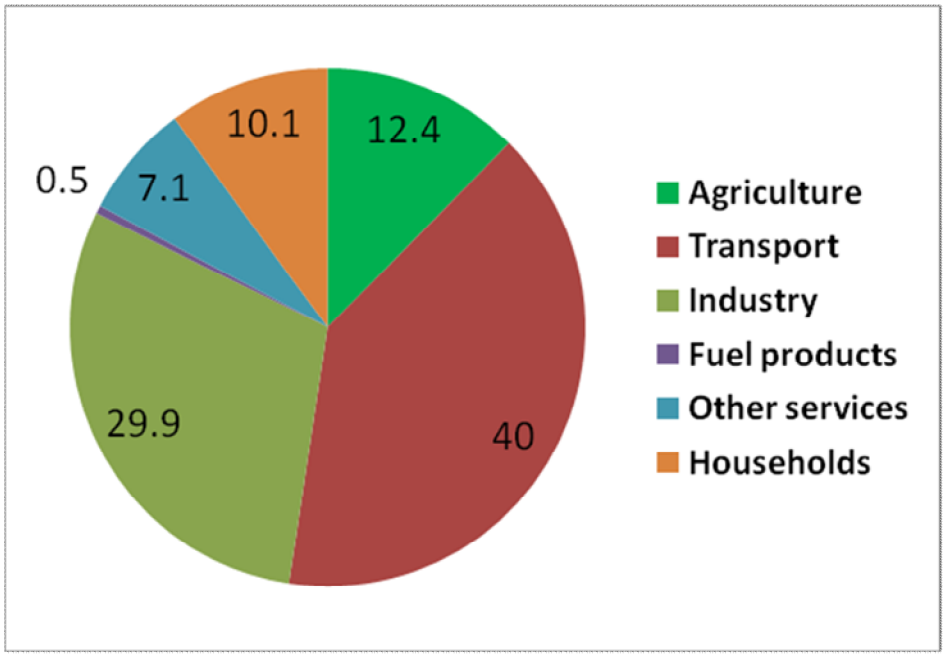






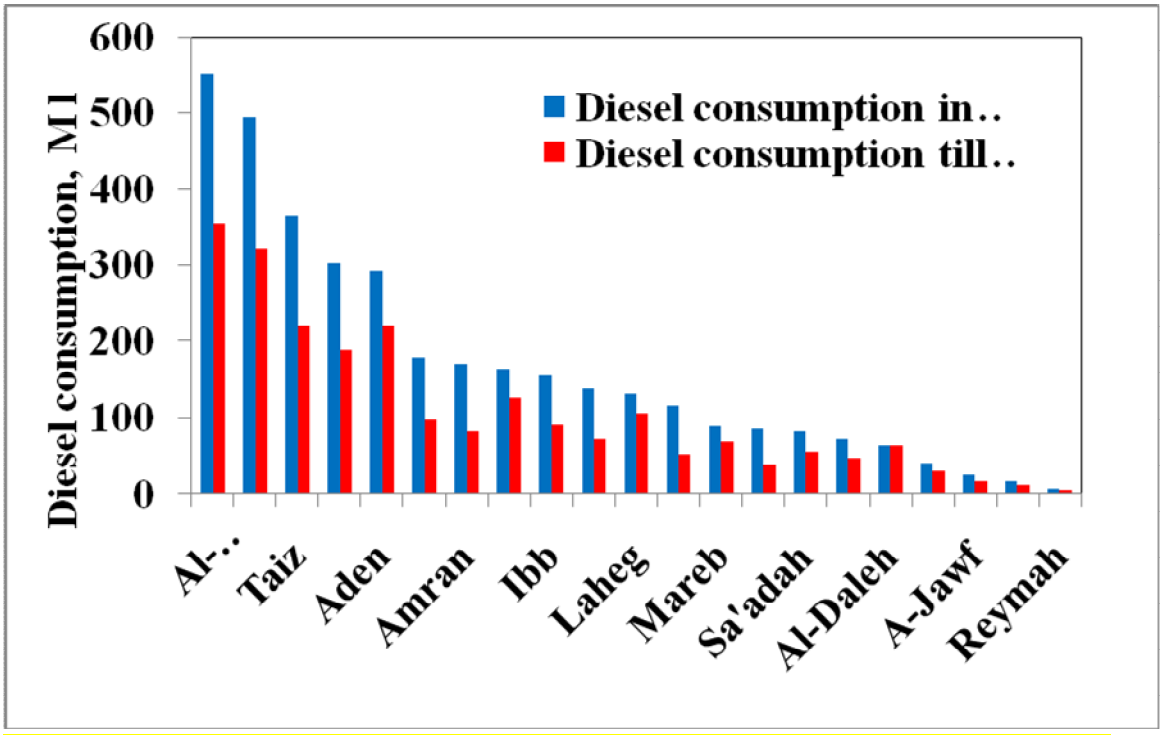
Data Source: GSCP, 2011

- Distribution of Fuel Consumption Amongst Economy Sectors



Data Source: Breisinger et al., 2011

- Comparison of Diesel Consumption by Governorates



Add analysis of the figure (inference? Why diesel consumption in Alhodeidah and Hadramout particularly so high? Can this be attributed to diesel smuggling through the sea to the countries of horn of Africa?)

- Documenting Impacts of Diesel Crisis of 2011 on Agriculture and Groundwater Pumping

This rapid assessment was conducted in six different regions of the country and each represents specific conditions. The data was collected using four sets of questioners, namely for farmers, for fuel station owners, for agricultural products wholesalers and for diesel fuel sellers at the black market (questionnaires included in the appendix)

The regions selected were as follows:

- Dhamar and Rada'a: located in the highlands, and are characterized by intensive well irrigation from deep aquifers especially for qat.
- Northern Tihama region: located on the western coastal plains is characterized by well irrication and relatively poor farmers.
- Sana'a basin: this basin is the most water stressed in the country.
- Wadi Hadramawt: the farms around Shibam city are totally dependent on well irrigation.
- Southern Tihama region (zabid): large farms of mango and bananas and fodder depend largely on well irrigation.
- Sa'adah: it is a typical case of complicated crises of water and armed conflicts.