



5^h Beirut Water week Water, energy, food and ecosystems nexus in the Mediterranean Region: Current Challenges and Future Insights

Impact of Syrian refugees on Water Resources Management in Lebanon

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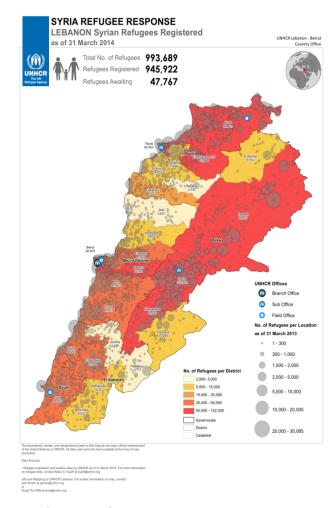
22-23 May, 2014, Notre Dame University - Louaize

Global changes in the MENA Region

- The region is experiencing a progressive climatic change from Mediterranean climate to semi arid climate.
- An increase of 2 to 4°C in the next years along with demography increase due to refugees movements.
- o The Arab Spring Political and Religious conflicts have increased population mass movement such as of the Syrian refugees with impacts on the social and economical life in Lebanon
- o **Lebanon** is affected this year by a heavy water shortage
- Water storage is much smaller and the snow in the mountain doesn't have the time to infiltrate the
 - stored resources.
- Moreover the country has usually a volume of 2.7 billion m3/y as renewable water resources, and this year this quantity will be around 1.6 billion m3/y.
- Syria: The country is very affected by the civil war since March 2011 and from climatic change which makes the country dryer. This situation has an impact on increasing the number of refugees and displaced to the neighboring countries.

Syrian refugees impact

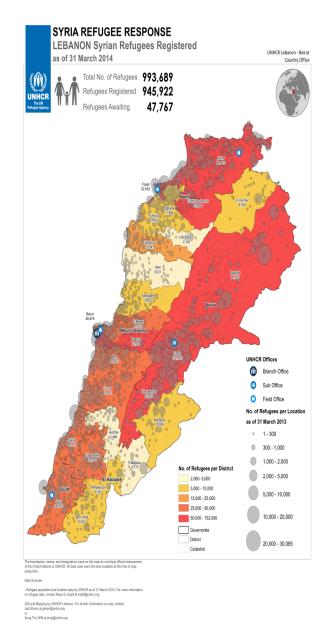
- The Syrian conflict started in 2011 and no end is foreseen until now.
- o 1.5 million of refugees in Lebanon (30% of the Lebanese population) and this number is expected to increase up to about 7 million until the end of 2015.
- Lebanon, which hosts others foreign refugees, is already under "pressure" and this situation is beyond its capacity to be managed equitably.
- The Syrian refugees are dispersed in different communities and regions.
- o **The communities** have a lot of problems to integrate the Syrian refugees because of political and religions identity.
- o ex: Tripoli which is already under pressure with local tensions hosts today 42000 Syrian refugees.



- Lebanon can't close its border: lack of political will and weak institutions (clandestine refugees).
- Many refugees have settled next to the borders.

Syrian refugees impact

- Since many years an anti Syrian ideology is present.
- o Syrians live in conditions of **very high poverty**: 1/3 have no **jobs**, most have lows wages and are not highly qualified for labor work.
- Impact on Lebanese labor because they are cheaper.
- Syrian have difficulties to afford daily life and housing: they often live in home/garage or tents (80 000).
- O Syrians refugees have **few access to safe water and** they don't have the means to buy bottled water.
- Some regions, like the Bekaa and Akkar, will experience a very hard water stress during the summer.
- Syrian live in this regions in very hard poverty conditions.
- The lack of water along with this year's hottest temperatures could be a source of tensions and conflicts.
- O The impact on Lebanon is huge: serious economic shocks due to the conflict in Syria, including a decline in trade, tourism and investment and an increase in public spending.
- If the situation will be reestablished in Syria it will take in Lebanon more than ten years to manage and rehabilitate the impacts due to the refugees.



Water stress in Lebanon

- Water pollution caused by industrial waste.
- Damaged infrastructures due to civil war (1975-1990).
- Lebanese government (1992- 2006) prefers to invest in the tertiary sector instead of the water infrastructures.
- Lack of water due to the global changes, decrease of precipitation and stockade infrastructure.
- Old irrigation technology Waste of water: 40 % (damaged infrastructures, 1.2 billion m³ of water flowing to the sea, no optimization of water management and daily life use).
- Sea water intrusion in the coastal areas.
- Illegal pumping from private wells for private use.
- Dams and hill lakes constructions projects slow down because of internal conflicts / tensions and public debts.
- Impact on the population and agriculture: lack of water mostly in arid regions, problems of quality and quantity: sanitation problem, difficulties to distribute and to have access to water.

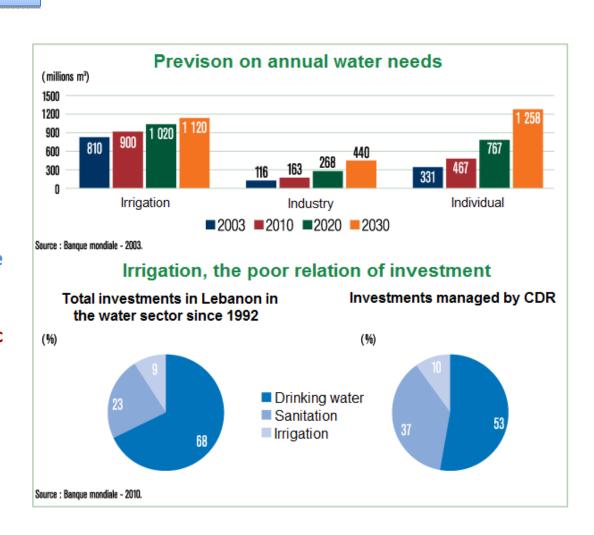
Water stress in Lebanon

A tourist uses 500 liters of water/day, a local user 50 liters/day.

Lack of snow for skiing economy.

300 million today in the deficit of the hydraulic balance.

The country could reach 1.7 billion cubic meters per year by 2040.



Water resources in Lebanon: Constraints in brief

Country "blessed" with abundant water resources, but...:

- ▶ 90% of rainfall occurs within a period of 3 months
- Lebanon's soil geological nature (Karstic)
- Groundwater is the major source used for water supply (overpumping, seawater intrusion, drop in water table level ...)
- Deficiency/low number of wastewater treatment plants
- Absence of surface water storage facilities
- Objectives of the 10-year IWRM strategic plan were not met
- Political and financial constraints
- ▶ Etc...





Water demand in Lebanon: IWRM

Two scenarios



Water Stress



Sustainable management - IWRM





Storage
Dams and hill lakes



Non Conventional

Network efficiency
Potable water 50% → 80% 2040
Irrigation: - new techniques
Water establishmentMinistry of Agriculture-

Hydraulic Balance

Lebanon Strategic Plan 2000-2010-2018

General Principles

- Ensure additional water storage installations (dams, lakes, recharge of aquifers...)
- Establish drinking water projects (Distribution **network and efficiency**, **Public Private Partnership** involvements,...)
- Consider various irrigation projects (Ensuring **food security**, network efficiency...)
- Ensure wastewater collecting projects and treatment plants (water reuse for irrigation, municipal use and artificial recharge of aquifers...).
- Consider infrastructures for flood mitigation, rectification and alignment of rivers beds.
- New Water Mass: Conventional and Non-conventional water

Actions in place

- NGO like CICR, CARE... local interventions with refugees. (ex: Zahle)
- International cooperation (70% of the funds provided from others countries) World Bank / cooperation with France.
- UN HRC intervention



Scenario 1: Unsustainable Management of Irrigation (100

	Scenario	1: Unsustainable N	Aanagement of Iri	rigati	on (1	10000)m3/h	na)					
ld.		Designation		20:	12	20	13	20:	14	201	.5	20	20
۸.1	ро	pulation LB (millior	ns)	5	.	5.14	F 0.4	5.27	c 77	5.42	6.9	5.5 6	714
A.1	pol	pulation SYR (millio	ns)	0.2	5.2	0.7	5.84	1.5	6.77	1.54	6	1.5 8	7.14
		Domestic &	m3/person/year	109	9.5	111	33	113	.15	114.	98	11	6.8
	industrial Use Total (Mm3/y		Total (Mm3/y)	569	9.4	649.58		766.44		799.	83	833	3.95
A.2	Water Demands	Agriculture	Surface (x10exp3 Ha)	14	5	15	50	1.5 1.54 113.15 114.98 766.44 799.83 160 190 1600 1900 2366.44 2699.83	2	00			
			Total (Mm3/y)	14	50	1500		160	00	190	00	20	000
	(General Total Mm3/	y	2019.4		214	9.58	2366	5.44	2699	6.9 6 98 83 0 0 .83 0 0	283	3.95
		Surface '	Water	120	00	15	00	16	00	175	0	17	'50
В	water Resources	Water	50	0	500		50	0	50	0	5	00	
		al	170	00	20	00	21	00	225	0	22	250	
C	Balance	Mm3/y with Popula	tion SYR	-31	9.4	-149	9.58	-266	5.44	-449	.83	-58	3.95
D	Balance M	m3/y without Popu	lation SYR	-297	.50	-71	.65	-96	.71	-272	.71	-39	9.41

Scenario 1	: Unsustainable	Management of	Irrigation	(10000m3/ha)
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	Sections	1. Olisustalilable i	nanagement of h	i igati	011 (3	.0000	/1115/1	iu,					
ld.		Designation		20:	20	20	25	203	30	203	35	20	040
0.1	ро	pulation LB (millior	ns)	5.56	7.1	5.71	7.22	5.86	7.52	6.02	7.7	6.1 9	7.04
A.1	pop	oulation SYR (millio	ns)	1.58	4	1.62	7.33	1.67	7.53	1.71	3	1.7 6	7.94
		Domestic &	m3/person/year	116	5.8	118	3.63	120	.45	122.	7.7 3 71 122.28 945.69 260 2600	12	4.1
		industrial Use	Total (Mm3/y)	833	.95	869.85		907.08		945.	69	985	5.72
A.2	Water Demands	Agriculture	Surface (x10exp3 Ha)	20	ı0	2.	20	24	0	26	0	2	80
			Total (Mm3/y)	2000		2200		2400					300
	G	General Total Mm3/	y	2833	3.95	306	9.85	3307	7.08	3545.69		378	5.72
		Surface \	Water	17	50	18	50	190	50	208	30	22	200
B water Resources Mm3/y	Ground '	ınd Water		0	500		50	0	50	0	5	00	
	Tota	al	22!	50	23	50	240	50	258	30	27	700	
С	Balance	Mm3/y with Popula	tion SYR	-583	.95	-719	9.85	-847	.08	-965	.69	-108	35.72
D	Balance M	m3/y without Popu	lation SYR	-399	.41			-646	5.35	-756	.42	-86	7.59

Scenario 2: Sustainable Management of Irrigation (7000m3/ha)

	Domestic & industrial Use Total (Mm3/y) 1.58 4 1.62 1.67 1.71 3 1.7 6 1.71 3 1.7 6 1.71 3 1.7 6 1.71 3 1.7 6 1.71 1.71 3 1.7 6 1.71 3 1.7 6 1.71 1												
ld.		Designation		20:	20	20	25	203	30	203	35	20)40
0.1	ро	pulation LB (millior	ns)	5.56		5.71			7.52	6.02	7.7	9	7.04
A.1	pop	oulation SYR (millio	ns)	1.58		1.62	7.33		7.53	1.71	3	1.7	7.94
		Domestic &	m3/person/year	116	5.8	118	3.63	120	.45	122.	2 7.7 3 1 2.28 5.69 600 65.69 080 600 55.69	12	4.1
		industrial Use	Total (Mm3/y)	833	.95	869	9.85	907.08		945.	69	985	5.72
A.2 Water Demands Agriculture	Agriculture	Surface (x10exp3 Ha)	200		2.	20	24	0	26	0	2	80	
	7.67.535	Total (Mm3/y)	1400			40	168					960	
	G	General Total Mm3/	y	2233	3.95	240	9.85	2587	7.08	2765.69		294	5.72
		Surface \	Water	17	50	18	50	190	50	208	30	22	200
B water Resources Mm3/y	Ground '	Water	50	00	50	00	50	0	50	0	5	00	
	Tota	al	22!	50	23	50	240	50	258	30	27	700	
С	Balance	Mm3/y with Popula	tion SYR	16.	05	-59	.85	-127	.08	-185	.69	-24	5.72
D	Balance M	m3/y without Popu	lation SYR	200.59 132.64		2.64			23.5	58	-27	7.59	

Scenario 3: Unsustainable Management of Irrigation (10000m3/ha) + Climate Change Effect 2 degrees

		i wanagement or m	0					.0-		0			
ld.		Designation		20	12	20	13	20:	14	201	L5	20	020
0.1	ро	pulation LB (million	is)	5		5.14		5.27	c 77	5.42	6.9	5.5 6	7.14
A.1	pop	oulation SYR (millio	ns)	0.2	5.2	0.7	5.84	1.5	6.77	1.54	6	1.5 8	7.14
		Domestic &	m3/person/year	109	9.5	111	33	113	.15	114.	.98	11	6.8
	industrial Use Total (Mm3/y) 569.4 649.58 766.44 799.3	.83	833	3.95									
A.2	Water Demands	Agriculture	Surface (x10exp3 Ha)	1.0		41	-0	1.0	.0	10	0	2.	00
		7.67.64.14	Total (Mm3/y)	145 1450			00	16		19 190			00
	G	General Total Mm3/	/	201	9.4	214	9.58	2366	5.44	2699	.83	283	3.95
		Surface \	Water	70	00	10	00	110	00	125	50	12	250
В	water Resources Mm3/y	Ground '	Water	50	00	50	00	50	0	50	6.9 6 98 83 0 .83 0 .0 .83	5	00
	Control of the Contro	Total	al	12	00	15	00	160	00	175	50	17	750
С	Balance	Mm3/y with Popula	tion SYR	-81	9.4	-649	9.58	-766	5.44	-949	.83	-108	33.95
D	Balance M	m3/y without Popu	lation SYR	-797	7.50	-571	1.65	-596	5.71	-772	.71	-89	9.41

Scenario 3: Unsustainable Management of Irrigation (10000m3/ha) + Climate Change Effect 2 degrees

New York Control of the Control of t		i wanagement or m						.0-					
ld.		Designation		20:	20	20	25	203	30	203	35	20	040
A 1	ро	pulation LB (million	s)	5.56	7.1	5.71		5.86	7.52	6.02	7.7	6.1 9	7.04
A.1	pop	oulation SYR (millio	ns)	1.58	4	1.62	7.33	1.67	7.53	1.71	3	1.7 6	7.94
		Domestic &	m3/person/year	116	5.8	118	3.63	120	.45	122.	28	12	4.1
		industrial Use	Total (Mm3/y)	833	.95	869	9.85	907.08		945.	69	985	5.72
A.2	Water Demands	Agriculture	Surface (x10exp3 Ha)	20	ıO.	27	20	24	ın	26	0	2:	80
A 2	2000 2200			2400					300				
	A.2 Agriculture Agriculture	378	5.72										
		Surface \	Water	12	50	13	50	140	60	158	80	17	700
В	water Resources Mm3/y	Ground '	Water	500		50	00	50	00	50	3 28 69 0 .69 0 .69	5	00
	a the second	Tota	al	17	50	18	50	190	60	208	30	22	200
С	Balance	Balance Mm3/y with Population SYR			3.95	-121	9.85	5 -1347.08		-1465	5.69	-158	35.72
D	Balance M	m3/y without Popu	lation SYR	-899	.41	-102	7.36	-114	6.35	-1256	5.42	-136	7.59

Scenario 4: Sustainable Management of Irrigation (7000m3/ha) + Climate Change Effect 2 degrees

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ld.		Agriculture (x10exp3 Ha) 200 220 240 260 Total (Mm3/y) 1400 1540 1680 1820 General Total Mm3/y 2233.95 2409.85 2587.08 2765.69				20	040						
0.1	ро	pulation LB (million	ns)	5.56		5.71	7.22	5.86	7.52	6.02	7.7	6.1 9	7.04
A.1	por	oulation SYR (millio	ns)	1.58		1.62	7.33	1.67	7.53	1.71	3	1.7 6	7.94
		Domestic &	m3/person/year	116	5.8	118	3.63	120	.45	122.	7.7 3 2.28 5.69 5.69 80 5.69	12	4.1
		industrial Use	Total (Mm3/y)	833.95		869.85		907.08		945.	69	985	5.72
A.2	Water Demands	Agriculture	And the second s	2.0					0	2.5	_		00
		Agriculture	Tatal (NA:-2 (.)	20	00	220 240 260 2	80						
			Total (IVIM3/y)	140	00	15	40	168	30	182	20	19	960
	A.2 Agriculture Agriculture Agriculture Agriculture (x10exp3 Ha) 200 220 240 260 Total (Mm3/y) 1400 1540 1680 1820	294	5.72										
		Surface \	Water	12	50	13	50	140	50	158	30	17	00
water Resources	Ground '	nd Water		0	50	00	50	0	50	0	5	00	
To	al	17	50	18	50	190	50	208	30	22	200		
С	Balance l	Mm3/y with Popula	tion SYR	-483	3.95	-559	9.85	-627	.08	-685	.69	-74	5.72
D	Balance M	m3/y without Popu	lation SYR	-299	.41	-367	7.36	-426	5.35	-476	.71 122.28 945.69 260 1820		7.59

Scenario 5 : Unsustainable Management of Irrigation (10000m3/ha) + Climate Change Effect 4 degrees

		ivianagement of m	0					.0		0			
ld.		Designation		20	12	20	13	20:	14	201	L5	20	20
0.1	ро	pulation LB (millior	is)	5		5.14		5.27	c 77	5.42	6.9	5.5 6	7 1 1
A.1	pop	oulation SYR (millio	ns)	0.2	5.2	0.7	5.84	1.5	6.77	1.54	6	1.5 8	7.14
		Domestic &	m3/person/year	109	9.5	111	33	113	.15	114.	98	11	6.8
		industrial Use To	Total (Mm3/y)	569	9.4	649	.58	766.44		799.	.83	833	3.95
A.2	Water Demands	Agriculture	Surface (x10exp3 Ha)	1.4	-	4.1	-0	1.0	.0	10	0	2	00
		Agriculture	T-+-1/042/-)	14	5	1:	50	16	0	19	98 83 0 .83 0	21	00
			Total (Mm3/y)	1450		1500		160	00	190	6.9 6 98 83 0 0 .83 0	20	000
	G	General Total Mm3/	1	201	9.4	214	9.58	2366	5.44	2699	.98 .83 .83 .00 .00 .00 .00 .00	283	3.95
		Surface '	Water	35	0	65	50	75	0	90	0	9	00
В	water Resources Mm3/y	irces	Water	50	00	500		50	0	50	0	5	00
	Tota	al	85	0	11	50	12	50	140	00	14	100	
С	Balance	ance Mm3/y with Population SYR			59.4	-999	9.58			-1299	9.83	-143	33.95
D	Balance M	m3/y without Popu	lation SYR	-114	7.50	-921	1.65	-946	5.71	-1122	2.71	-124	9.41

Scenario 5: Unsustainable Management of Irrigation (10000m3/ha) + Climate Change Effect 4 degrees

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ld.		Designation		20	20	20	25	203	30	203	5	20	040
0.1	ро	pulation LB (million	ns)	5.56	7.1	5.71	7.22	5.86	7.52	6.02	7.7	6.1 9	7.04
A.1	pop	oulation SYR (millio	ns)	1.58	4	1.62	7.33	1.67	7.53	1.71	3	1.7 6	7.94
		Domestic &	m3/person/year	116	5.8	118	3.63	120	.45	122.	7.7 3 2.28 5.69 60 5.69 230 230 25.69	12	4.1
		industrial Use	Total (Mm3/y)	833	.95	869.85		907.08		945.	69	985	5.72
A.2	Water Demands	Agriculture	Surface (x10exp3 Ha)	20	0	2.5	20	24	0	20	0	2	80
A.Z	- G	Total (Mm3/y)	2000		22		24(260			300	
	G	General Total Mm3/	/	2833	3.95	306	9.85	3307	7.08	3545.69		378	5.72
		Surface \	Water	90	0	10	00	11:	10	123	0	13	350
B water Resources Mm3/y	Ground '	Water	50	0	50	00	50	0	50	0	5	00	
	•	Tota	al	140	00	15	00	16:	10	173	80	18	350
С	Balance	m3/y with Population	tion SYR	-143	3.95	-156	9.85	-169	7.08	-1815	5.69	-193	35.72
D	Balance M	m3/y without Popu	lation SYR	-124	9.41	-137	7.36	-1490	6.35	-1606	5.42	-171	17.59

Scenario 6: Sustainable Management of Irrigation (7000m3/ha) + Climate Change Effect 4 degrees

эсста	no o . odstamasie	Management of in	igation (7000ms)	iia) i	Cilli	iate e	, iiuiig	C LIIC	oc i a	281003			
ld.		Designation		20:	20	20	25	203	30	203	5	20	40
A 1	ро	pulation LB (million	s)	5.56	7.1	5.71	7.22	5.86	7.52	6.02	7.7	6.1 9	7.04
A.1	рор	oulation SYR (millio	ns)	1.58	4	1.62	7.33	1.67	7.53	1.71	3	1.7 6	7.94
		Domestic &	m3/person/year	116	5.8	118	3.63	120	.45	122.	7.7 3 2.28 5.69 5.69 30 5.69	12	4.1
		industrial Use	Total (Mm3/y)	833	.95	869.85		907.08		945.	69	985	5.72
A.2	Water Demands Agriculture	Surface (x10exp3 Ha)	200		220		2.4	0	26	0		0.0	
		Agriculture	Total (Mm3/y)					24			3 28 69 0 .69		80
			Total (Willis/y)	140	00	15	40	168	80	182	20	19	60
	G	General Total Mm3/	/	2233	3.95	240	9.85	2587	7.08	2765	.69	294	5.72
		Surface \	Water	90	0	10	00	11:	10	123	0	13	50
В	water Resources	Ground '	d Water		500		00	50	0	50	0	5	00
То	al	140	00	15	00	16:	10	173	0	18	350		
С	Balance	Mm3/y with Popula	tion SYR	-833	.95	-909	9.85	-977	7.08	-1035	5.69	-109	5.72
D	Balance M	m3/y without Popu	lation SYR	-649	.41	-717	7.36	-776	5.35	-826	.42	-87	7.59

			Ge	eneral Ta	able					
		2012	2013	2014	2015	2020	2025	2030	2035	2040
Scenario 1	with Population SYR	-319.4	-149.58	-266.44	-449.83	-583.95	-719.85	-847.08	-965.687	-1085.72
Unsus.	without Population SYR	-297.50	-71.65	-96.71	-272.71	-399.41	-527.36	-646.35	-756.417	-867.588
Scenario 2	with Population SYR					16.048	-59.851	-127.081	-185.687	-245.716
Sus.	without Population SYR					200.592	132.637	73.64588	23.58302	-27.5883
Scenario 3	with Population SYR	-819.4	-649.581	-766.438	-949.827	-1083.95	-1219.85	-1347.08	-1465.69	-1585.72
Unsus.	without Population SYR	-797.5	-571.654	-596.713	-772.708	-899.408	-1027.36	-1146.35	-1256.42	-1367.59
	with Population SYR					-483.952	-559.851	-627.081	-685.687	-745.716
Scenario 4 Sus.						-299.408	-367.363	-426.354	-476.417	-527.588
	without Population SYR									
Scenario 5	with Population SYR	-1169 /	-909 581	-1116 ///	_1200 83	-1/133 05	-1560 85	-1697.08	-1815 60	_1935 72
Unsus.		-1105.4	-333.361	-1110.44	-1233.63	-1433.33	-1309.63	-1097.08	-1013.03	-1933.72
	without Population SYR	-1147.5	-921.654	-946.713	-1122.71	-1249.41	-1377.36	-1496.35	-1606.42	-1717.59
	with Population SYR					.022.052	000.054	077.004	1025.60	1005 72
Scenario 6 Sus.						-833.952	-909.851	-977.081	-1035.69	-1095.72
	without Population SYR					-649.408	-717.363	-776.354	-826.417	-877.588

Conclusion

Lebanon is under pressure with the increasing number of Syrian refugees hosted and with climate-related impacts which affects the water resources. It is possible that several conflicts and tensions break out across the country in different places for different reasons: policy, lack of resources, communities tensions. Theses tensions and conflicts can be triggered by the lack of water provided to the population and to the refugees. That can occur as soon as the temperatures rise during the hottest season. Here we have a warning threshold problems that can lead to a civil and community war. The construction of dams was one of the solutions to cope with climate change and people water needs, but local tensions have slowed it down. How can we construct dams if there are again tensions? Moreover these dams need the population contribution and higher prices to fund the project. How can people give more if labor price is down and if Lebanon is affected by conflicts? We have to quickly react to find a solution to give access to safe water to the local population and refugees in the hot season. The plans settled by the Lebanese authorities and NGO cannot be realized over several years. Therefore the government has to cooperate with the international institutions and emergency NGO to avoid a conflict and distribute water to the increasing populations which lives in Lebanon.