EAP-Irrigation Management Modernization
AAA - TA - P130522

Country Assessments:

Focus on "ET-Based Integrated Water Management in the Turpan Basin"

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Country Assessments

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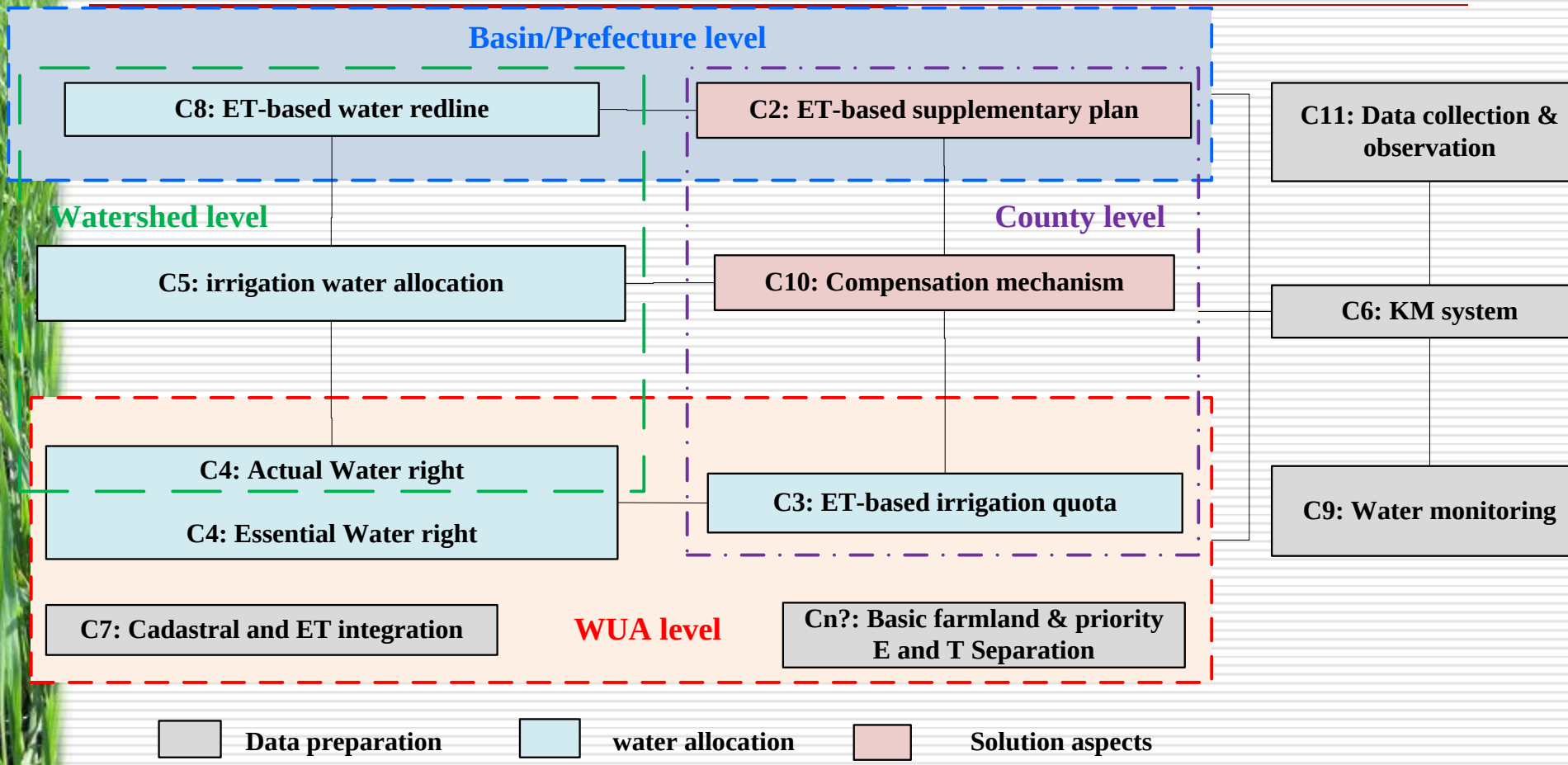
Country Assessments

1. Introduction

Reason of Choice-Turpan Basin

- "ET-Based Integrated Water Management in the Turpan Basin" project from World Bank
- Extremely dry climate, shortage of water resources;
- Seriously over-exploit groundwater, environment deterioration;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Cn?: Basic farmland & priority E and T Separation
Data preparation
water allocation
Solution aspects

Country Assessments

2. National Baseline

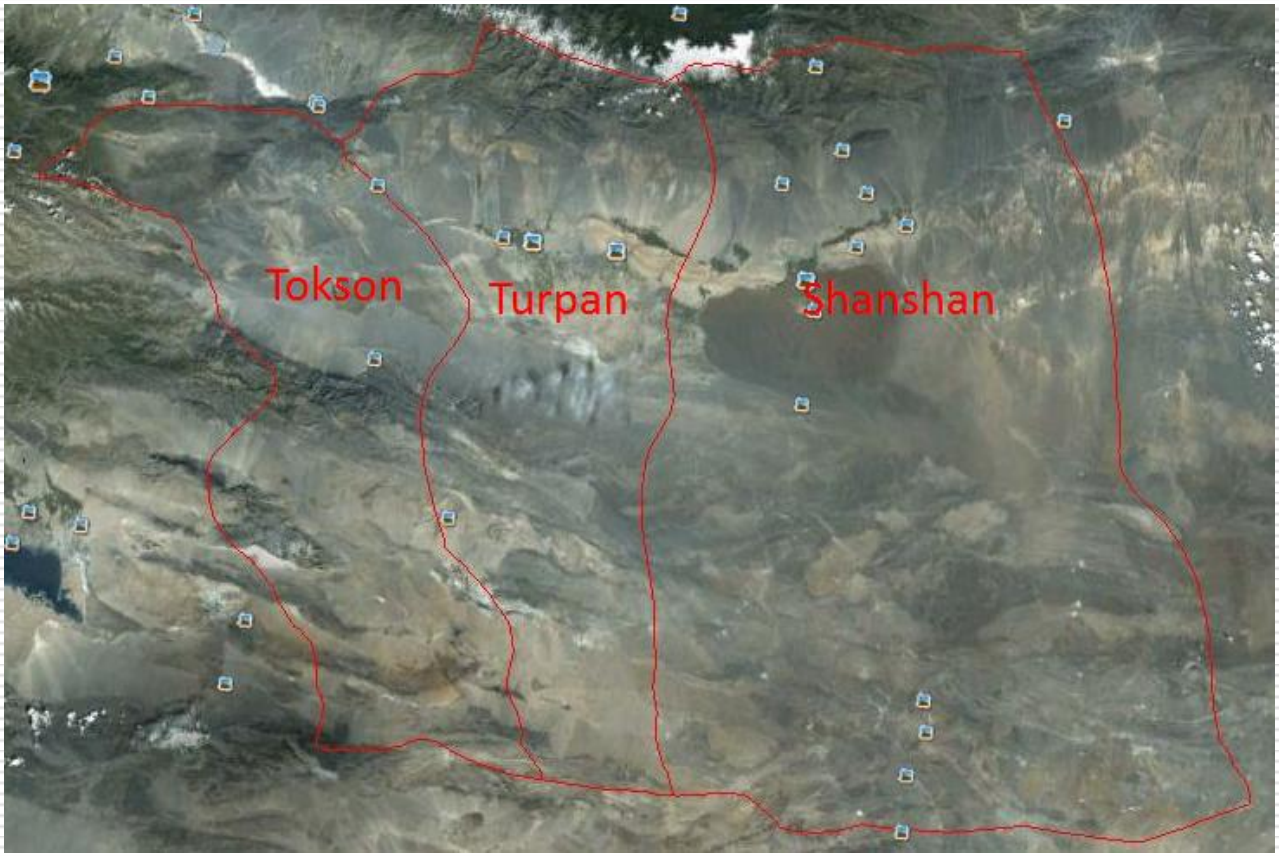
Background of Water for China

- Urbanization, food security, green civilization
- Shortage of water in north China, Serious pollution of surface water and groundwater over China;
- National water resources Plan approved by State Council in 2010;
- Decision to accelerate reform and development of water conservation as No.1 directive in 2011, which layout three redlines:
  - Limitation on water retrieve amount
  - Increase water use efficiency
  - Water quality on return water

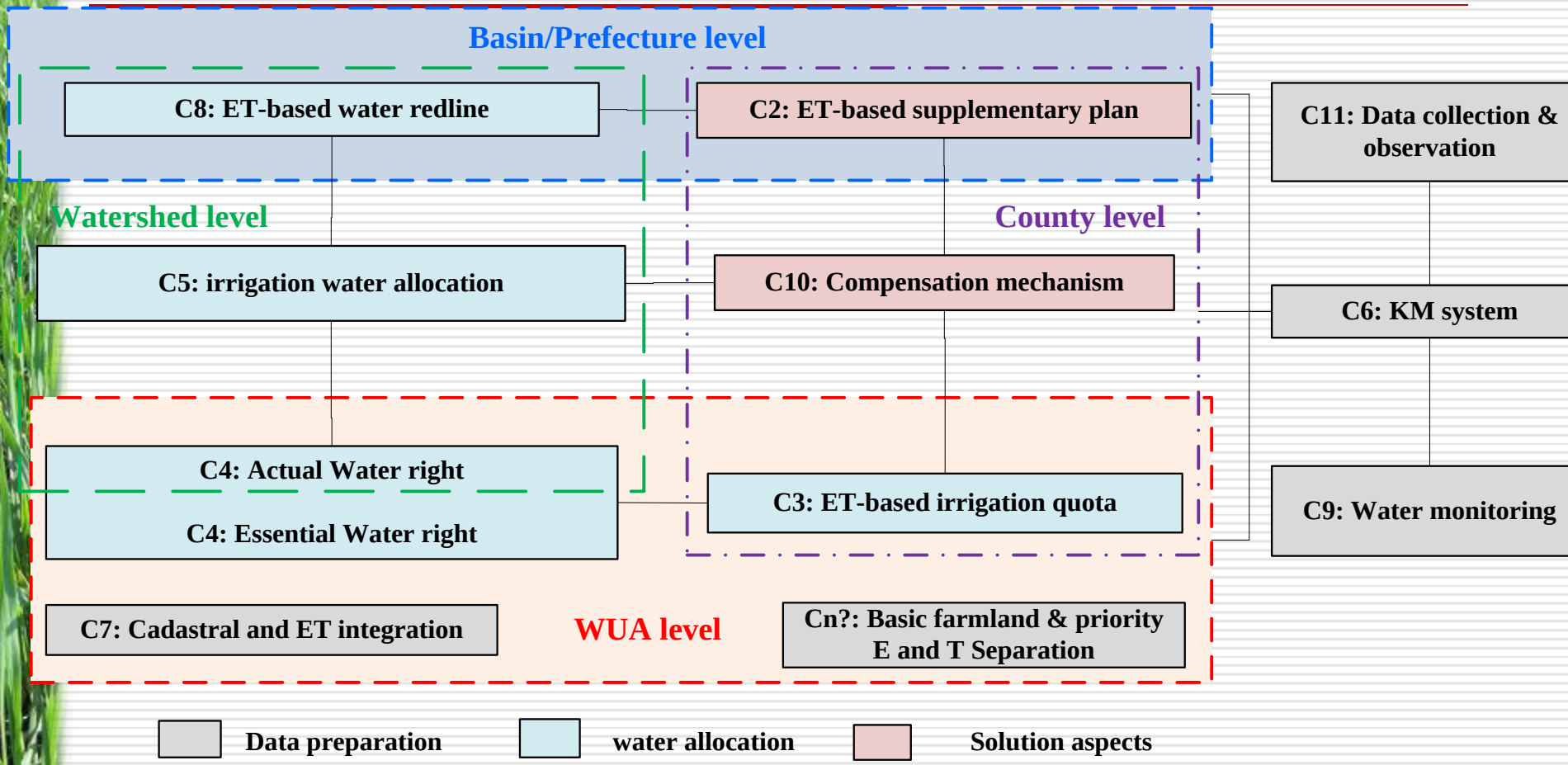
Country Assessments

3. Assessment of the present situation

3.1 Basin level: Turpan Basin



The satellite image of Turpan Basin, including Tokson, Turpan and Shanshan.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Accounting-Turpan Basin

Water Resources Accounting

hydrological regionalization	river name	catchment area	water amount(billion cubic)
Tokson 2 river watershed	Baiyang River	2,423	1.36
	Keerjian Channel	646	0.21
	Yuer Channel	628	0.45
	Ala Channel	2503	1.26
	Zhulumutu Channel	257	0.05
	Wusitong Channel	617	0.14
	sum	7074	3.47
Turpan and Shanhan 7 River watershed	Kekeya River	707	1.12
	Ertang Channel	501	0.82
	Qialekan River	100	0.09
	Hei River	185	0.33
	Meiyao Channel	481	0.81
	Taerlang Channel	443	0.77
	Daheyan River	724	1.04
	sum	3141	4.98
Kanerqi watershed	Kanerqi River	548	0.29
sum		10763	8.74
groundwater amount			0.41
precipitation in project area			2.87
sum			12.02

Accounting-Turpan Basin

Water Consumption Accounting

	unit	basin	Turpan City	Shanshan County	Tokson County
project area	KM2	19166.63	6139.75	6721.19	6301.5
Water Resources Amount	0.1billion m3	12.0159	4.4299	3.4142	4.251
surface water amount(I)	0.1billion m3	8.74	3.04	2.23	3.47
natural supply amount for groundwater(I)	0.1billion m3	0.41	0.2	0.1	0.11
precipitation for project area	0.1billion m3	2.8659	1.1899	1.0842	0.671
flowout amount(O)	0.1billion m3	0.0786			0.0786
actual water consumption for present year	0.1billion m3	14.243	5.5955	4.9152	3.5127
crop water consumption(ETagr)	0.1billion m3	6.1956	3.0961	2.6646	2.2113
environment and ecology water consumption(ETeco)	0.1billion m3	7.8229	2.4921	2.2437	1.2955
living and livestock water consumption	0.1billion m3	0.0703	0.0073	0.007	0.006
industrial city water consumption(WCurb)	0.1billion m3	0.1542			
Tertiary industry water consumption	0.1billion m3				
evaporation from reservoir surface(ETeco)	0.1billion m3				
groundwater storage variable	0.1billion m3	-2.3057	-1.1656	-1.501	0.6597

Bargaining-Turpan Basin

Agriculture irrigation consumes 93.3 of the water resources, contribute to 10% of the GDP in Turpan; Mineral and industry consume 6% of the water resources, contribute to 90% of the GDP in Turpan

- Re-allocating water to urban and rural area based on ET, how much can be used sustainable, with compensation;
- The core of reduce water consumption is reducing evaporation;
- For efficiency red line, industry and agriculture with low water productivity should be restricted, and irrigation efficiency under water consumption line should be improved.
- The purpose of irrigation efficiency improvement is to reduce the chance of evaporation instead of enlarging the irrigation area.
- Present and historic water consumption should both be considered in the ET allocation process;
- The rights and interests of ordinary farmer should be compensated with priority in the process of returning farmland to water;
- Knowledge management(KM) system should be able to display water right and priority for every farmland lot.

Water Consumpmtion Plan for Turpan Basin

Items in Water Balance Equation[1]	Water Items	Baseline Year			Target Year 2025					
		Area Hectare	mm	Amount 10^6m^3	Area Hectare	mm	Amount 10^6m^3	Change to Baseline mm	Change to Baseline 10^6m^3	Change to Baseline %
Available Water Resources	1. Precipitation	1,916,744	14.95	286.59	1,916,663	14.95	286.59			
	2. Water inflow			874.00			874.00			
	3. Groundwater baseflow			41.00			41.00			
	Total Available			1201.59			1201.59			
Water Consumption	1. Ecological ET	484,188	85.10	412.04	498,119		412.04			0%
	1.1 Man-made ET	2,950	208.52	6.15						
	1.2 Natural ET	481,238	84.34	405.88						
	2. Water Surface ET	14,013	240.45	33.69	14,197		29.48		-4.21	-13%
	2.1 Man-made ET	963	293.68	2.83	1,147		5.21		2.38	84%
	2.2 Natural ET	13,050	236.52	30.87	13,050		24.28		-6.59	-21%
	3. Agricultural ET	114,206	542.49	619.56	114,206	318.62	363.89	-223.87	-255.67	-41%
	3.1 Crop ET	94,275	631.04	594.91	54,275	533.87	289.76	-97.16	-305.15	
	3.2 Non crop ET	19,931	123.68	24.65	59,931	123.69	74.13	0.00	49.47	
	4. Unused Land ET	1,304,338	25.80	336.57	1,304,338		336.57	0.00	0.00	0%
	5. Industries			15.42			100.00		84.58	549%
	6. Domestic Use			7.03			20.00		12.97	185%
	Total Consumption			1424.30			1261.97		-162.33	-11%
Outflow				7.86			7.86		0.00	0%
Change in Groundwater Storage				-230.57			-68.24		162.33	-70%

Codification-Turpan Basin

- Develop supplement plan on ET-based agricultural irrigation to exploit and evaluate ways of realizing target ET on watershed scale;
- Transferring traditional 3 redlines to ET-based redlines, providing guidance for water consumption plan and water allocation.
- Establish rigorous and fair mechanism of returning farmland to water, work plan on closing well and returning farmland has being carried out in Turpan
- Develop the groundwater recovery program for Turpan Basin using water consumption balance method in the frame of national water resources plan;

Water saving potential Analysis in Turpan

Units 10^9 m^3

Scheme	Agriculture measure Abandon Farmland $20*10^4$mu	Agriculture measure Abandon Farmland $30*10^4$mu	Agriculture measure Abandon Farmland $40*10^4$mu	Agriculture measure Abandon Farmland $50*10^4$mu	Agriculture measure Abandon Farmland $60*10^4$mu
Water saving from farm to Greenhouse $50*10^4$mu	1.4947	1.4947	1.4947	1.4947	1.4947
Water saving from farm irrigation $20*10^4$mu	0.4813	0.4813	0.4813	0.4813	0.4813
Water saving from abandon farmland	0.7972	1.1958	1.5944	1.993	2.3916
Total water saving	**2.77**	**3.17**	**3.57**	**3.97**	**4.37**
Industry water requirement	0.5	1	1.5	2.5	3.5
Living water requirement	0.6814	0.6814	0.6814	0.6814	0.6814
Living and Industry consummed water	0.3915	0.6165	0.8415	1.2915	1.7415
Total consummed water(realize the balance between draft and recharge)	**2.93**	**3.15**	**3.38**	**3.83**	**4.28**

- **The Total farm land area is about $160*10^4$mu;**
- **The overdraft ground water is 230 million m^3; The water saving by agriculture measure is only 197 million m3, so the farmland abandoned is the necessary to stop overdraft of ground water**
- **The Living and industrial water consumption could be 174 million m3 if the water requirement increased to 350 million m^3 ;**

Delegation-Turpan Basin

- Carry out strict water quota management, systematic authorization, promote to reform water resources management method further;
- Government should promote high-income industry to compensate water losses in agricultural sector;
- Establish appropriate supervision and verification mechanism to ensure the compensation action;
- Turpan ET Management Center has been established to manage water resources in Turpan based on ET.

Engineering-Turpan Basin

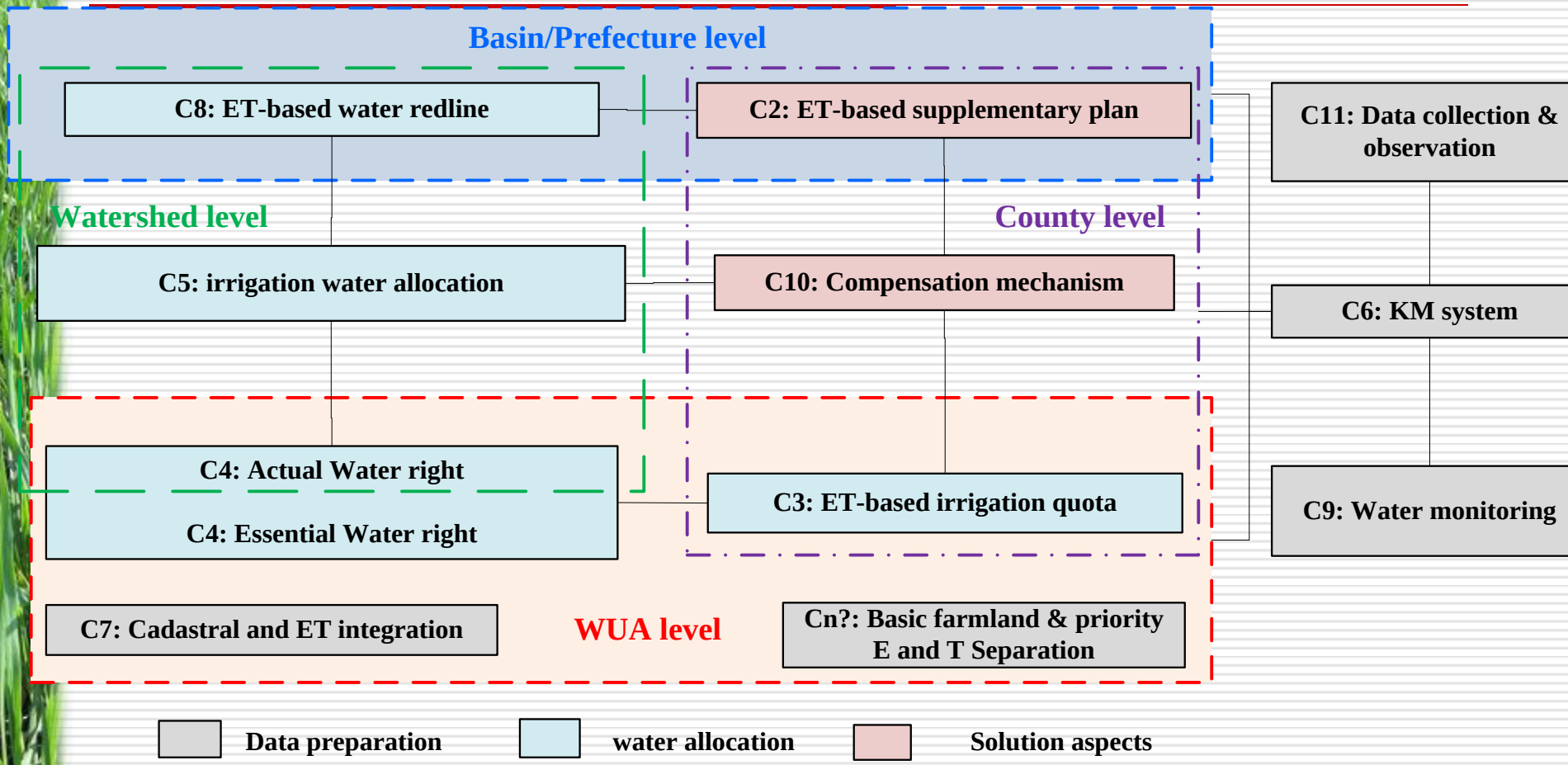
- Three reservoirs, new canals, water saving irrigation etc.
- At preset:
  - Turpan Basin has 17 reservoir with total capacity of 103 million m3;
  - Water-saving irrigation area 320,000 mu, drip irrigation area 190,000 mu and pipe irrigation area 130,000 mu;
  - 22km main canals, 66km branch canals, 206km lateral canals, total 294km canals for Turpan Basin;
  - Existing 6405 pumping wells, 972 wells with flow meter;
- Establishing surface water and groundwater monitoring system for whole Turpan Basin, monitoring all the wells both quantity and quality in real time to control over-exploiting underground water.

Feedback-Turpan Basin

- Drip irrigation for melons, cottons and grapes has been applied, better economic return;
- Returning farmland to water, control farmland area to ensure farmland is within the water resources bearing capacity;
- Develop water consumption management system for Turpan, supporting water resources consumption and allocation plan;
- KM system can display the decreasing of agricultural water consumption and corresponding groundwater change, feedback to the decision-makers. The system will be managed by ET Management Center of Turpan Basin.

3.2 Irrigation system level: Ertang Irrigation Area

The satellite image of Ertang Channel, the main experiment site of ET-based water resources management project from world bank.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Accounting-Ertang

Water Consumption Accounting

		present year
watershed area	km2	1625.69
oasis area	km2	357.71
oasis area of the county	km2	534.35
percentage of the county	%	66.94%
reservoir area	km2	
water resources amount		15897.21
ater resources amount(I)	10,000m3	9960.50
lateral piedmont(I)		2219.30
water resources amount(P)	10,000m3	3717.41
flowout amount(O)	10,000m3	0.00
actual water consumption	10,000m3	26878.14
agricultural water consumption(ETagr)	10,000m3	17574.10
environment and ecology water consumption(ETeco)	10,000m3	9175.83
living water consumption	10,000m3	31.86
industrial city water consumption(WCurb)	10,000m3	96.35
evaporation from reservoir surfac(ETeco)	10,000m3	
groundwater storage variable	10,000m3	-10980.93

- Water resources of Ertang Channel is 0.159billion m3.

Bargaining-Ertang Irrigation Area

- Using surface water with priority, limiting groundwater use;
- Water allocation plan should meet the crop target ET and increase farmer’s income;
- Ertang Reservoir will be used to regulate the allocation of water resources for this irrigation system;
- Compensation mechanism for returning farmland to water should be discussed with farmers fairly.
- Water resources fee will be charged if more than groundwater quota;

Codification-Ertang

- ET-based 3 redlines, providing guidance for water consumption plan and water allocation.
- Actual and essential water right in Ertang Watershed
- Irrigation system should implement the Management Measures for Turpan Groundwater Resources;
- Management Ordinance for Ertang Channel Reservoir and water resources regulation mechanism;
- Develop the adjusted standard of water allocation in wet and dry years based on available water amount from frequency analysis.

Delegation-Ertang

- Approving drilling well license, installing meter to the well to manage groundwater resources;
- Develop effective management and control mechanism to allocate water resources within the irrigation system for first and once-more time based on irrigation quota and water right configuration;
- Shanshan Water department will be authorized to manage Ertang Channel Reservoir and providing water allocation service based on the development of agriculture and industry in the down reach.

Engineering-Ertang

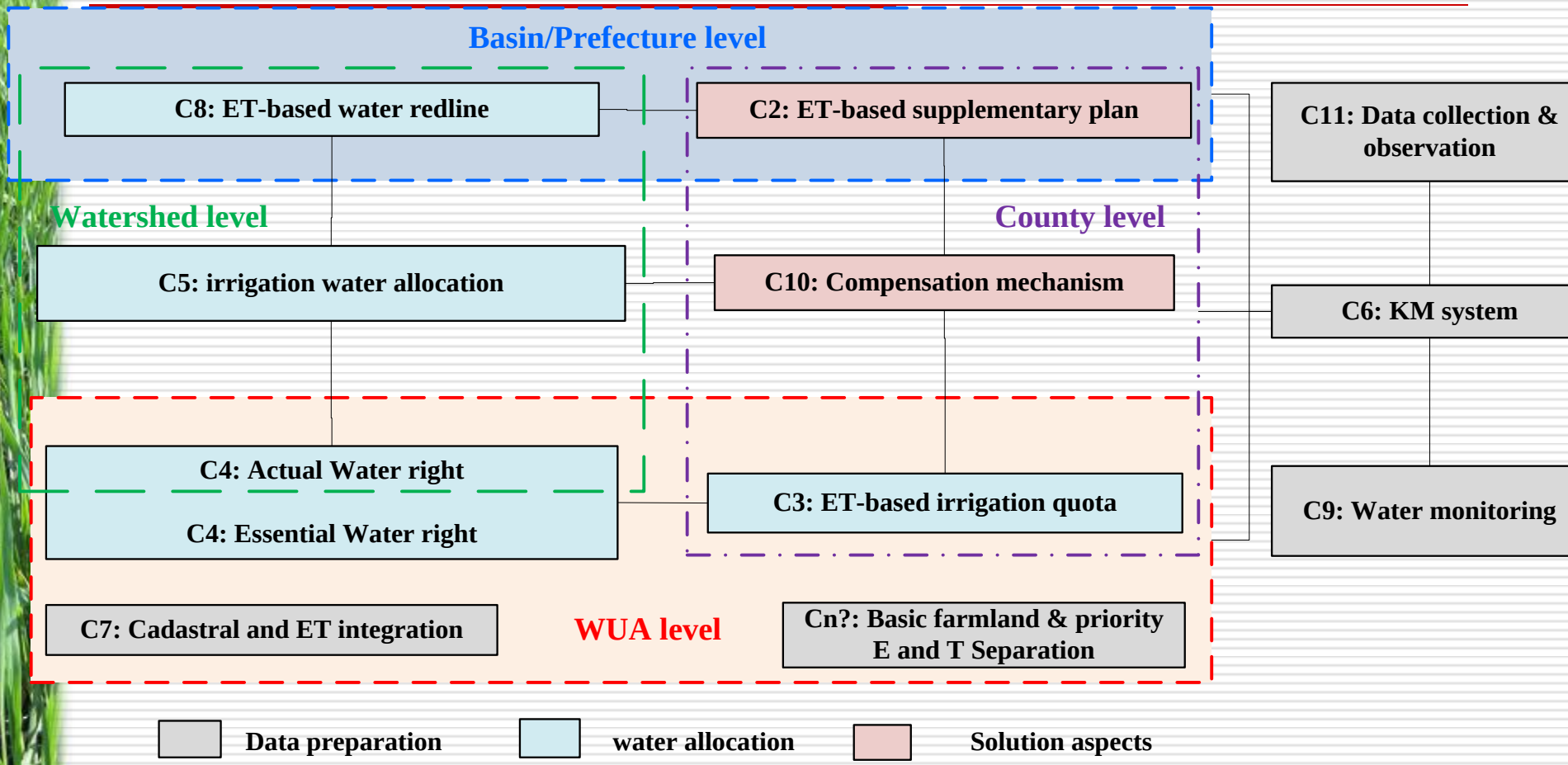
- Ertang Channel Reservoir is being constructed on Ertang Channel River to control flood of the upper reach;
- Total storage capacity is 25 million m3, storage capacity for flood control is 0.85 million m3, the barrage is 66 m in height, controlling irrigation area 0.2 million acres;
- It is a dynamic process to adjust the water amount by the reservoir;
- Drip and pipe irrigation was being applied in world bank program area.

Feedback-Ertang

- The built of Ertang Reservoir will be helpful to increase water usage efficiency to meet both industry and irrigation agriculture in the down reach;
- It is also helpful to flood protection in the down reach;
- Water-saving project, such as drip and pipe irrigation, is helpful to save water resources, stop the trend of over-mining groundwater;
- If exists, the climate change feedback should be considered in the water allocation process.

3.3 Water User Association level: WUA

Satellite image of WUA and farmland lot scale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Accounting-WUA

- ET mapping at high resolution, better with E/T separation
- Water productivity mapping
- Target ET and ET based irrigation quota should be accounted for every WUA.
- Tuyu Village belonging to Shanshan county is the remote-sensing based ET experiment site, should have 1 WUA
- 43 WUAs will be organized under world bank project, 13 in Turpan City, 16 in Shanshan County and 14 in Tokson County;

Bargaining-WUA

- Establish a bridge between water users and water suppliers, farmer can take part in managing water resources directly;
- Water rights configuration in WUA is developed based on adjusted irrigation quota
- Develop compensation mechanism for returning farmland to water;
- Basic farmer’s water rights should be met with priority, insufficient water should be acquired from industry and rich family;
- Transpiration within WUA should be guaranteed with priority, evaporation should be reduced as soon as possible.
- WUA was organized persisting in voluntary, open and democratic principles;

Codification-WUA

- Actual and essential water right for households
- Regulatory system for WUA should be established to ensure water supply to households, measured to households, accounts to households and being charged to households.
- Regulatory system includes responsibilities of Executive Committee members, operation management manual, registration card for irrigation area, financial management system, project management system, irrigation management system, reward and punish system.

Delegation-WUA

- The project leadership team of County is responsible for the development of WUA, WUA in the village is managed by head of township;
- Turpan City and County progressively authorizing local village and WUA to manage the wells, pipes and other basic infrastructures within the WUA scale according to the regulations.
- Every farmer within WUA should optimize the available water resources not more than the water consumption quota. The actual ET is provided to monitor the actual water consumption for every farmer.

Engineering-WUA

- Construct and repair the basic irrigation infrastructure within the WUA , supported by the government, to ensure the normal operation of WUA after its formally organization;
- Every WUA is responsible for the wells, pipes, end channels and other water infrastructures within the WUA, if damaged, the Executive Committee should organize the repair work in time;
- A demonstration monitoring system of surface water and groundwater will be established in Ertang Channel Irrigation System and also includes the water right allocation experiment.

Feedback-WUA

- WUA feedback to ET Management Center the water consumption monitoring result, which was used to adjust the irrigation quota;
- WUA will promote to use water resources standardly, institutionally and publicly;
- Water consumption will be acquired by merging cadastral and ET information, target ET will be adjusted in time, different water usage plan will be made and adjusted.
- KM system should be able to feedback to the ET Management Center the real-time monitoring information, for example, surface water and groundwater monitoring.

Country Assessments

4. Assessment of the desired Long Term Situation

The farmer's income calculation table for Turpan Basin

parameters	symbol	unit	example	Turpan
Average farm size	A	hectares	1.5 ha	0.95ha
Yield of main crop	T	t/ha	4.5 t/ha	6 t/ha
Cropping intensity	I %	%	150%	70%
Farm gate price of main crop	P	$/t	300$	1448.1$/t
Input costs	C	$/ha	120$	2413.5$/ha
Number in Farm Household	H		5	4
Net Farm Income per Capita	A*T*(P-C)*I/H		1.5*4.5*(300-120).1.5/5	(6t/ha*1448.1$/t-2413.5$/ha)* 0.95ha*70%/4
Result		$	364.5	1043.24$
Current Average	G	$	4000	4544$
Ratio	A*T*(P-C)*I/H/G		4000/364	4544$/1043.235375$
计算结果			11	4.36
instructions：1 dollar=6.215yuan				

The ratio is 4.36, indicating the income of Turpan farmer should be increased by organize WUA or commercial farm to attain to average GDP of Turpan Basin.

Country Assessments

5. Assessment of the short-term Actions

Short-term assessments

- ET-based water resources management project in Turpan focuses on water consumption balance analysis method, by which Turpan can truly saving water resources and control the trend of over-exploiting groundwater;
- The saved water resources will be used to promote the fast development of industry and increase the GDP of Turpan;
- The increased GDP in industry will be used to compensate the farmers due to their water right has been transferred. As a result, the farmer’s income will also be increased.

Country Assessments

6. Summary and Conclusions

Summary and Conclusions

- The trend of over-draft groundwater should be stopped at once for China by using all kinds of available technologies;
- The potential of saving water lies in agriculture, effective water-saving irrigation technique should be developed to save water for industry;
- Remote sensing based ET monitoring technique provide new water consumption balance analysis method to manage water resources.

Thank you!