EFs of the Yellow River

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Hekouzhen

Wanjiazhai Dam

Lijin

Sanmenxia Dam

HuaYuanKou

Luhun Dam

Guxian Dam

Serious Water scarcity but big population.

Huge sediment which increase flood crisis.

Total length 5464km. **Drainage area 795,000km^2.**

Population 156 million. **Average annual precipitation 452mm**

Average annual runoff 58 b m^3. **Groundwater 11 b m^3**

annual sediment load 1.6 billion tons . Sediment concentration 35kg/m^3.

Background

- Water allocation Plan In 1987:

58 billion m^3 (Average annual runoff) → **53.5** b m^3

37 billion m^3 (mankind) **+21billion m^3** (river)

?? **??**

What's the EF 'right volume for right time?

How to understand EFs?

- **EFs**: the flow required for maintaining the river's natural function at an acceptable lever

How to understand EFs?

- **Symbols of the healthy Yellow River:**

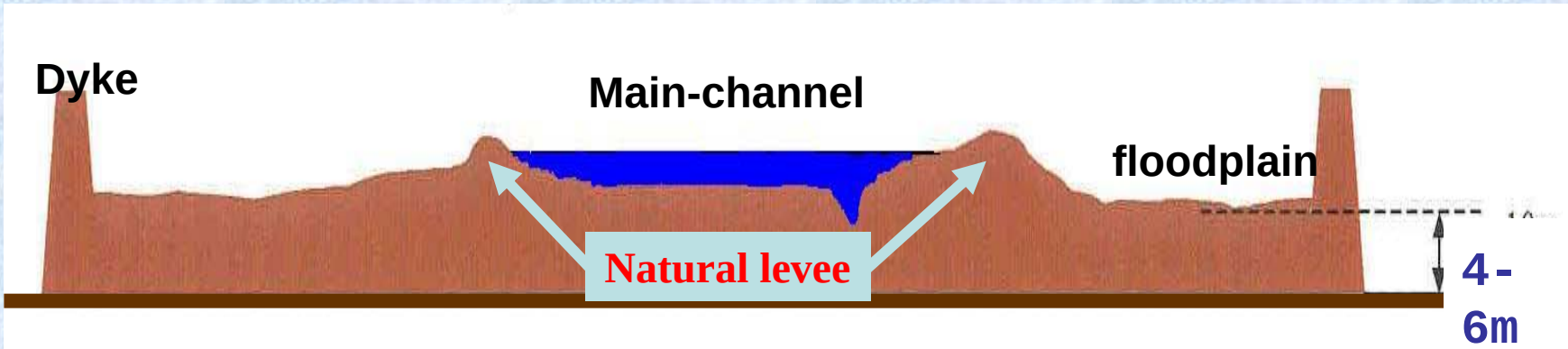
  --Favorable riverbed (main-channel)

  The main-channel is its main path for flood and sediment transportation, because it has smaller resistance to flood and large flow velocity.

  --Acceptable water quality

  --Favorable river ecosystem

EFs of YR: the flows required for favorable main-channel, water quality and river ecosystem.



How to understand EFs of the Yellow River ?

The key steps to identify the river's EF:

----the goals of river natural function protection and their relation with the runoff :

main-channel about 4000m^3/s,

water quality degree,

ecosystem in its early 90's

---- Integration and balance between the water requirements of the mankind and the natural

----adaptive adjustment through the practice

1 Flow (Flood) for keeping the discharge capacity of the main-channel

Two key factors:

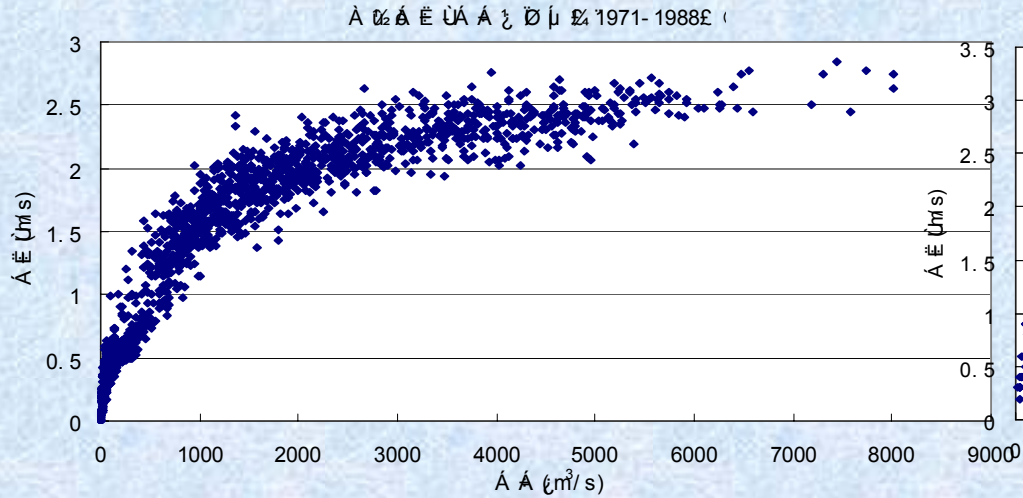
- How much sediment should be carried to the delta area?
- Which kind of flow regime (discharge) would be used to carry the sediment or to scour the riverbed?

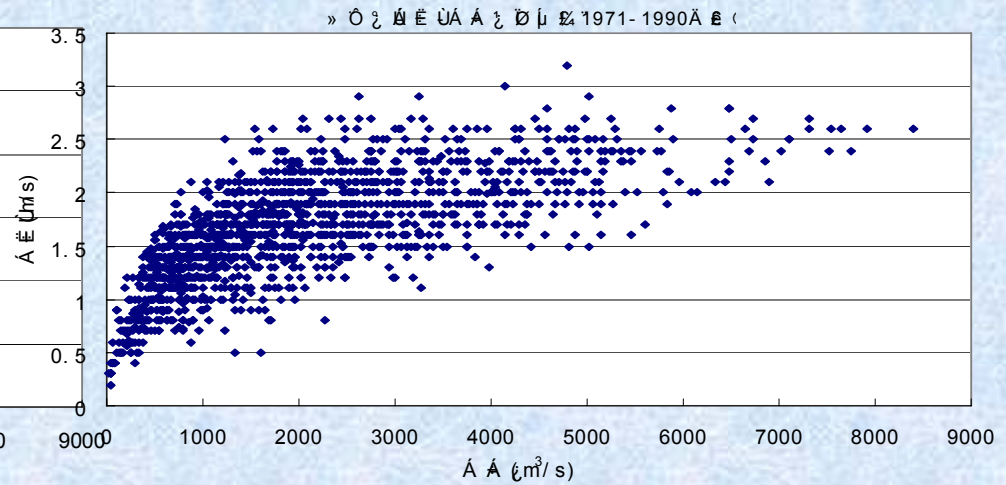
How much sediment will be carried to the delta area?

- Natural sediment load: 1.6 billion t (1919~1969)
- 1980~2005: 0.712 billion t. Why?
  --precipitation (torrential rain) decreasing?
  --effective soil erosion controlling?
  --dams construction?
- In future, sediment load in the lower Yellow River under the condition of average precipitation:
  ----0.5~0.6 before 2020~2030
  ----0.7~0.8 after 2020~2030
- In future, the sediment will concentrate in the flood season!

Which flow regime will be applied ?

- which kind of flow regime (discharge) **should be** used to carry the sediment or scour the riverbed?
- For the lower Yellow River, the discharge 3500~4500 m3/s is almost the most effective discharge for sediment transporting and riverbed scouring (its velocity reach at its highest point) .
- So, if possible, the discharge should’nt be less than it!





- It is possible to produce such a discharge of larger than 3500m3/s by Xiao-Lang-Di reservoir now!
- Why not change the natural smaller flood into such a discharge?

- Its sediment carrying capacity is about 50 kg/m3.

Flood Volume for keeping the discharge ability of the main-channel at 4000m3/s

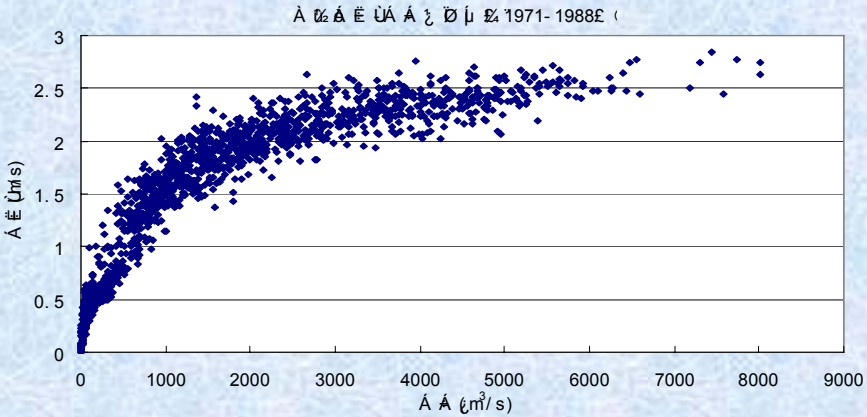
- Sediment load: 0.7~0.8 billion t in 2030~2050; 0.5 billion t before 2030
- Flood regime: normally 3500~4500m3/s with a sediment carrying capacity of about 50 kg/m3; seldom larger than 6000m3/s which is very helpful to enlarge the main-channel and to deal with sediment.
- Flood volume for keeping the discharge ability of the main-channel at 4000m3/s:

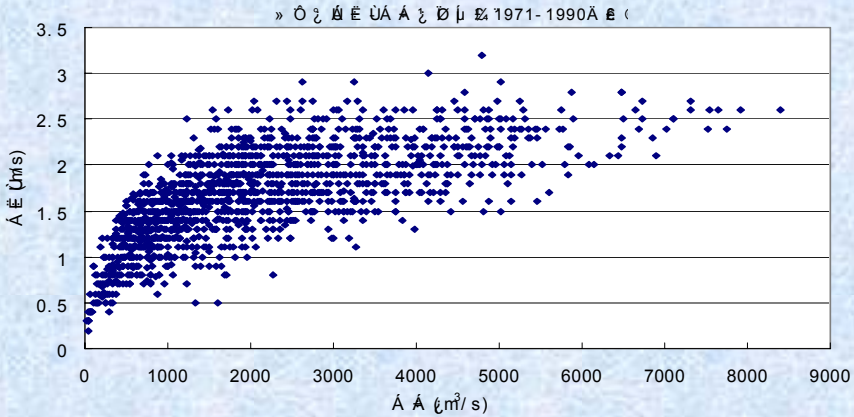
  15 billion m3 after 2030; 10 billion m3 before 2030

  which must be preformed in the discharge of around 4000m3/s

2 Flow for river ecosystem

- 2.1 Flow for aquatic creatures :
- Lots of studies have been done in the world and many methods have been put up.
- Agreement: enough water quantity and natural runoff regime
- Main way: find the turn point from the relation curve of habitat and runoff
- Situation in YR: **even larger than average discharge**





2 Flow for river ecosystem

2.1 Flow for aquatic creatures :

--lower biodiversity and simple ecosystem

--Suggested method:

(1) natural runoff series for the original ecosystem:

1919 a -1952 a

(2)find the key habitat parameters: Velocity & Depth

(3) in order to obtain a similar eco-runoff process as its natural annual runoff, replace the average natural annual discharge of Tennant by the average natural month discharge.

(4) verify it by the real discharge and water-depth parameters which is suitable for typical fishes in different seasons.

Flow requirement for the aquatic

section	Jan.	Feb.	March	April	May	June	July	Augus	Sept.	Oct.	Nov.	Dec.
Hekouzhen	65	65	65	65	270	270	300	300	300	300	135	65
Tongguan	105	105	160	325	325	470	500	500	500	500	235	105
Huayuankou	120	120	180	360	360	530	550	550	550	550	265	120
Lijin	125	125	185	370	370	535	580	580	580	580	265	125

Need more research & collaboration!

2 Flow for river ecosystem

- 2.2 Flow for the wetlands

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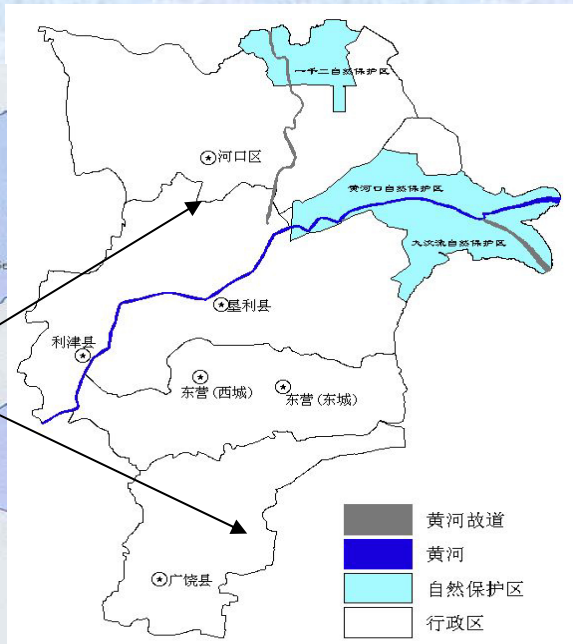
about 6~7 billion m3



3 Flow for water quality

- In theory, people should control their sewage release according to the river's purification capacity. So, the method of 7Q10 (average discharge of 7 dry days during latest 10 years) was put up and the resulted discharge was took as the base to calibrate sewage carrying capacity of the river.
- But, if we look at the Lower Yellow River's drying-up situation during 1986-2002, we'll find that it would produce unreasonable result: very small discharge even 0 m^3/s! which means that the sewage release into river must be banned completely. That is obviously impossible since China still is in her developing condition.

----The method didn't consider the river's social background.

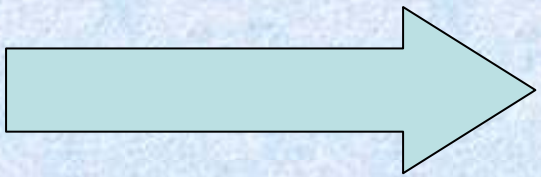
3 Flow for water quality

- **Self-purification flow:**

----water quality goal: □

----the type of the pollution: COD & NH_4

----total quantity and distribution of the sewage released into river



Section	Discharge
Hekouzhen	120 m^3/s
Longmen	210
Tongguan	380
Xiaolangdi	260
Huayuankou	290

4 Required EFs

- **Integration of the water requirement for all the natural function: 23~24 billion m3**
- **Water required for the mankind: 40 billion m3**
- **Total runoff of the River: 52~53.5 billion m3**

How can we expect the River could bear both?

Both compromise!

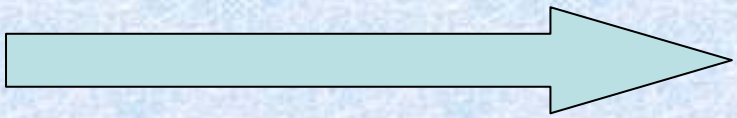
EFs: 19~20 billion m3;

Mankind: 32-33 billion m3

4 Suggested EFs of YR

Sect.	Jan.	Feb.	March	April	May	June	July	Aug	Sep.	Oct.	Nov.	Dec.
HKZ	120	120	120	120	120	120	300/1500	300	300	300	120	120
TG	380	380	380	380	380	380	500/2000	500	500	500	380	380
HYK	290	290	290	290	290	500	500/4000	500	500	500	290	290
LJ	100	100	150	200	200	250	500/4000	500	500	500	250	100

Control the sediment load less than 0.6 billion t.



Yellow Line

Adaptive adjustment is waiting:
deposition and creatures

5 Minimum flow

- Can people and nature compromise without dead line? No!---- Dead line (red line):
- to maintain the river's life, aquatic creature's life and people's drinking water.

Sect.	Jan.	Feb.	March	April	May	June	July	Aug	Sep.	Oct.	Nov.	Dec.
HKZ	40	40	40	40	70	70	150	150	150	150	70	40
TG	55	55	80	80	80	120	240	240	240	240	120	55
HYK	140	140	180	190	200	230	340	340	340	340	210	140
LJ	60	60	90	90	90	130	290	290	290	290	130	60

Stop all the sewage and sediment release

Practices

- United Water Distribution Program in whole YR has been lasting for more than 7 years….
- 7 manmade floods (named as Flood and Sediment Regulation Program) has been made since 2002. …..
- **Going very difficultly at beginning period.**
- **Achievements present:**

----no drying-up happen again from 1999.

----delta wetland shrinkage stop and even increased by 20%

----some valuable fishes appear again

---- bank-full discharge increased from 2000 to 3800 m^3/s

▲Still can't satisfy with the desired EF.

▲ There is still a long way to go !