HR Wallingford
Working with water

Introduction to hydrometry

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Hydrometric data
Scope

Types of hydrometric data

Validation of the observations

Reduction and processing

Production of information

> Exceedence probabilities

> Statutory requirements ?

> Project requirements ?

Hydrometric data analysis
Types of data

Rainfall measurements

- daily gauges
- self-recording gauges

Water levels

- staff gauges
- self-recording devices

River flows

- Direct measurement
- Structures
- Rating curves

Precipitation
Main features

Intensity

> Amount of rain falling in a given time (mm/hour)

Duration

> Period over which rain falls

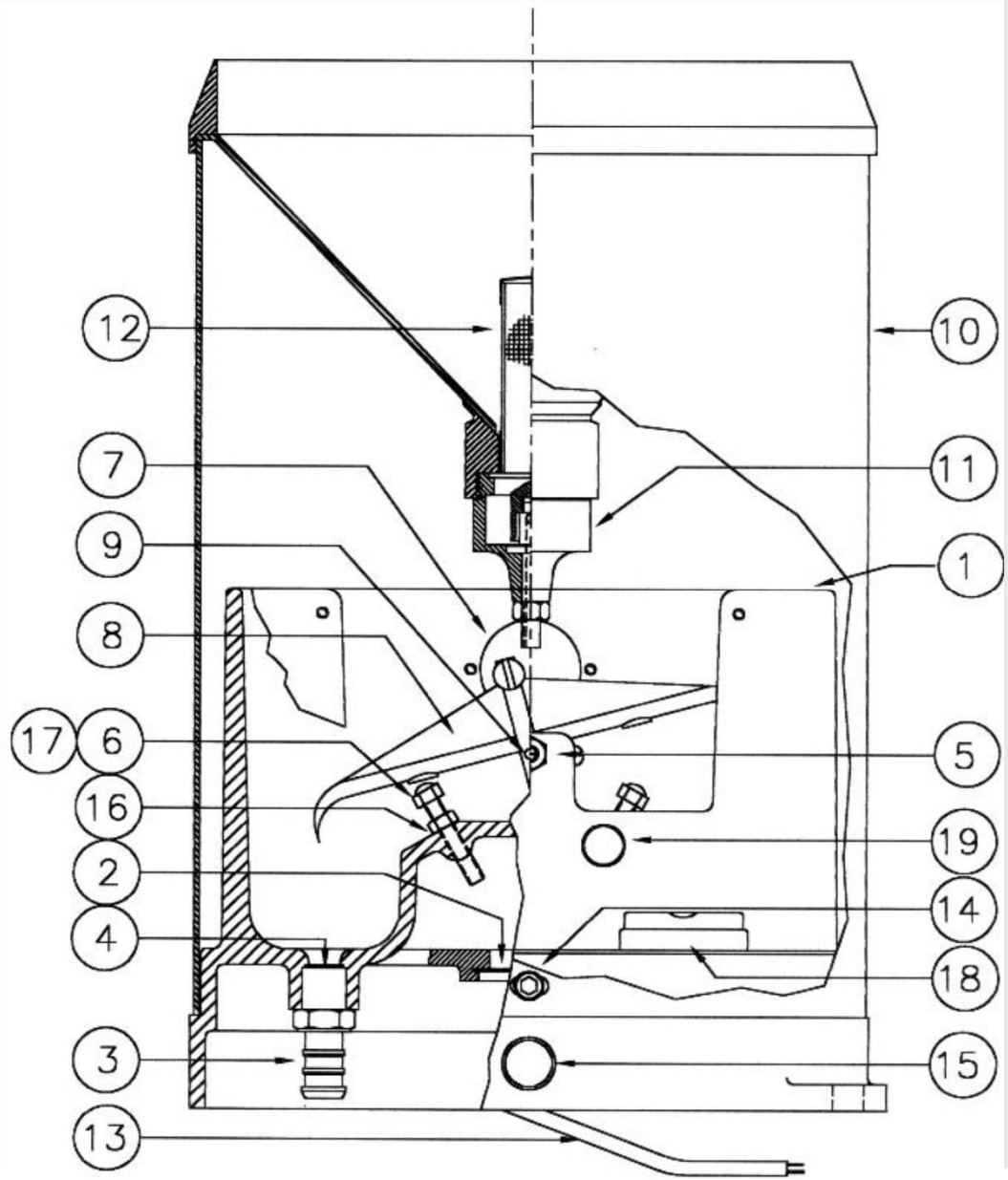
Frequency

> Occurrence with which a certain depth of rain is likely to occur in a given time

Areal extent

> Area over which a point measurement can be held to apply

Tipping-bucket raingauge



Precipitation
Issues to be aware of

> Daily gauges may not be read every day

> Data needs to be checked by Met Office (several months)

> Daily total – Normally applies at 9am for previous 24 hours

> Beware of ‘dry’ days followed by large total on a regular basis

> Don’t be afraid to query data quality

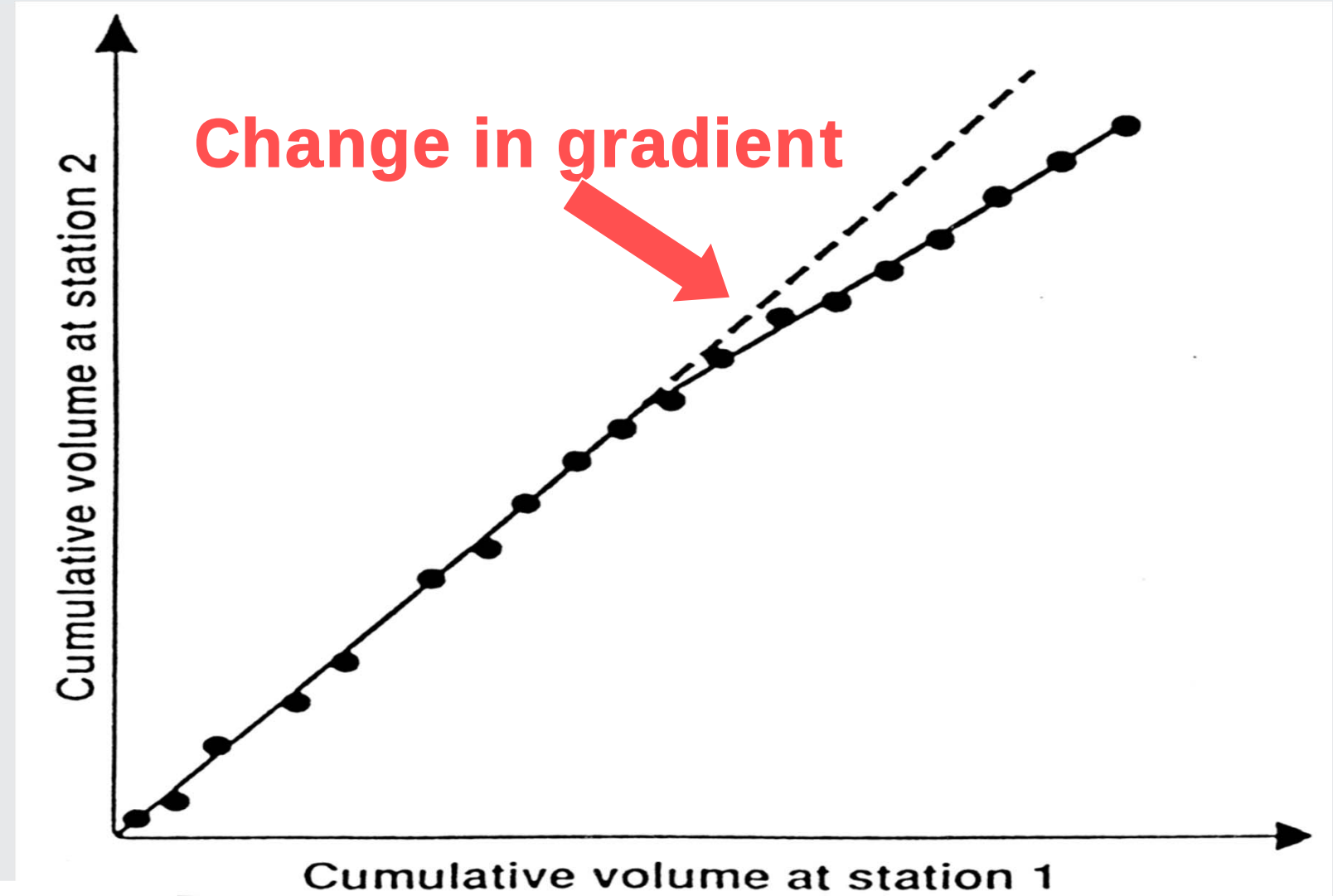
Hydrometric data analysis
Sources of error and uncertainty

- Change in collection equipment
- Equipment calibration
- Levelling errors, change in datum
- Movement of gauge boards
- Change in river cross-section shape
- Human error (transcription, typing, calculation)

Checking for errors
Double mass analysis

- A quality control check on long-term data sets
- Uses two independent sources of data
- Plot cumulative volume from the data sets
- Use flow or rainfall
- Look for changes to gradient
- Might also pick up impact of development on runoff

Checking for errors
Typical double mass curve



Checking for errors
Peak to peak correlation

> Match up corresponding features of hydrographs
> Checks on travel times
> Checks on inflow rates
> For guidance only in flow comparisons
> Basis of simple flood warning systems

Rating curves
Derive information from data

> Relate river level or depth to discharge

> Unique or looped curves

- Storage and slope of flood wave

> Allow data validation by checking latest measurements against earlier ones

> Care needed when there is a change of hydraulic condition (e.g. out-of-bank flow)

> Allows for extrapolation above the highest recorded flow

Rating curves
Typical rating equations

> General form of rating over a range of level

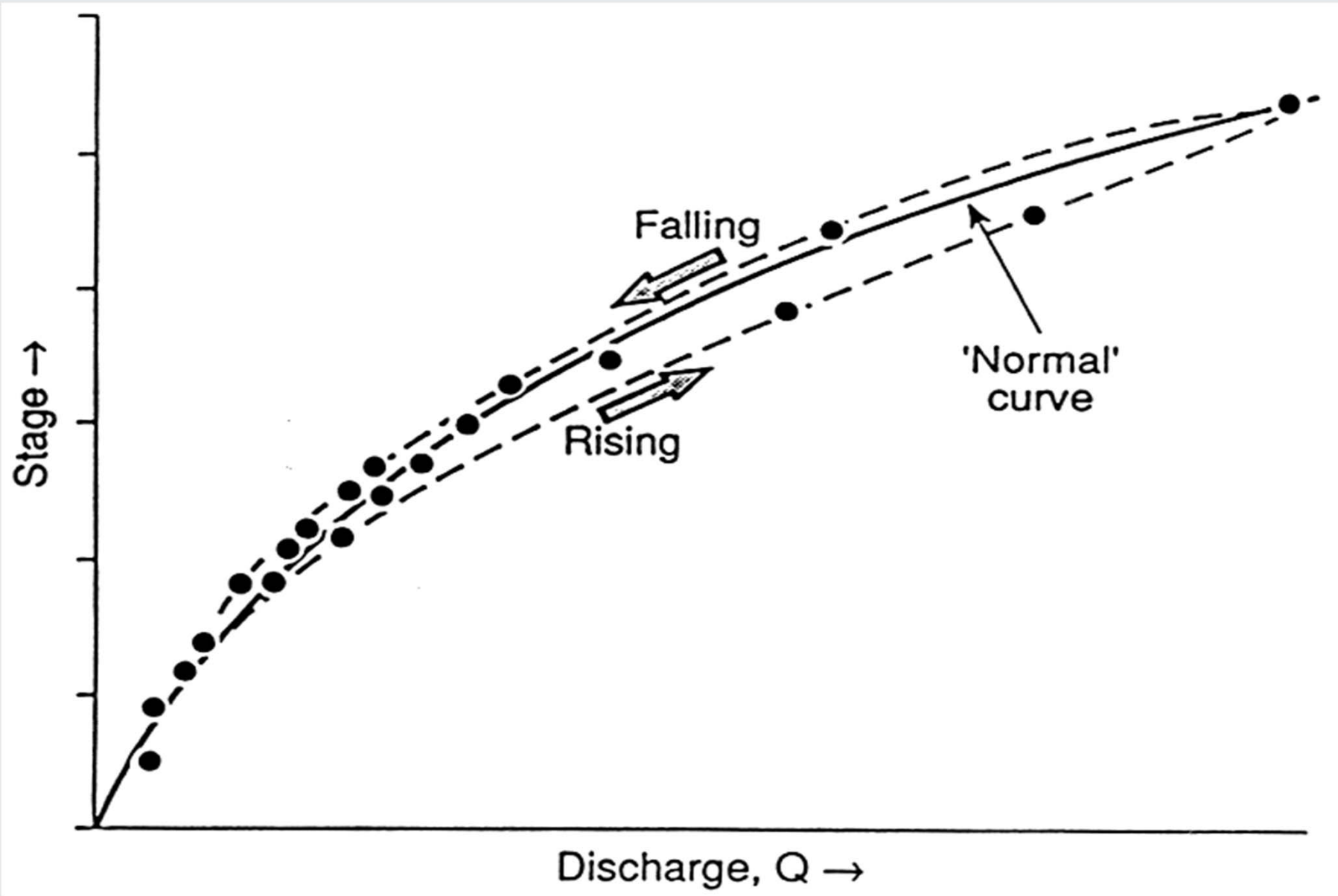
$$Q = A (h - b)^c$$

- Q is the flow
- h is the stage
- Coefficient b represents a local datum
- Coefficient c has some theoretical values for structures and simple cross-sections

> Log - Log fitting by eye or with software

> Several equations, each for a range of level, or change in channel shape through time

Rating curves
Typical example:



Rating curves
Adjustment for looped rating

> Adjust observations for rising or falling stage during measurement

> Measured discharge exceeds “normal” flow on rising flood stage

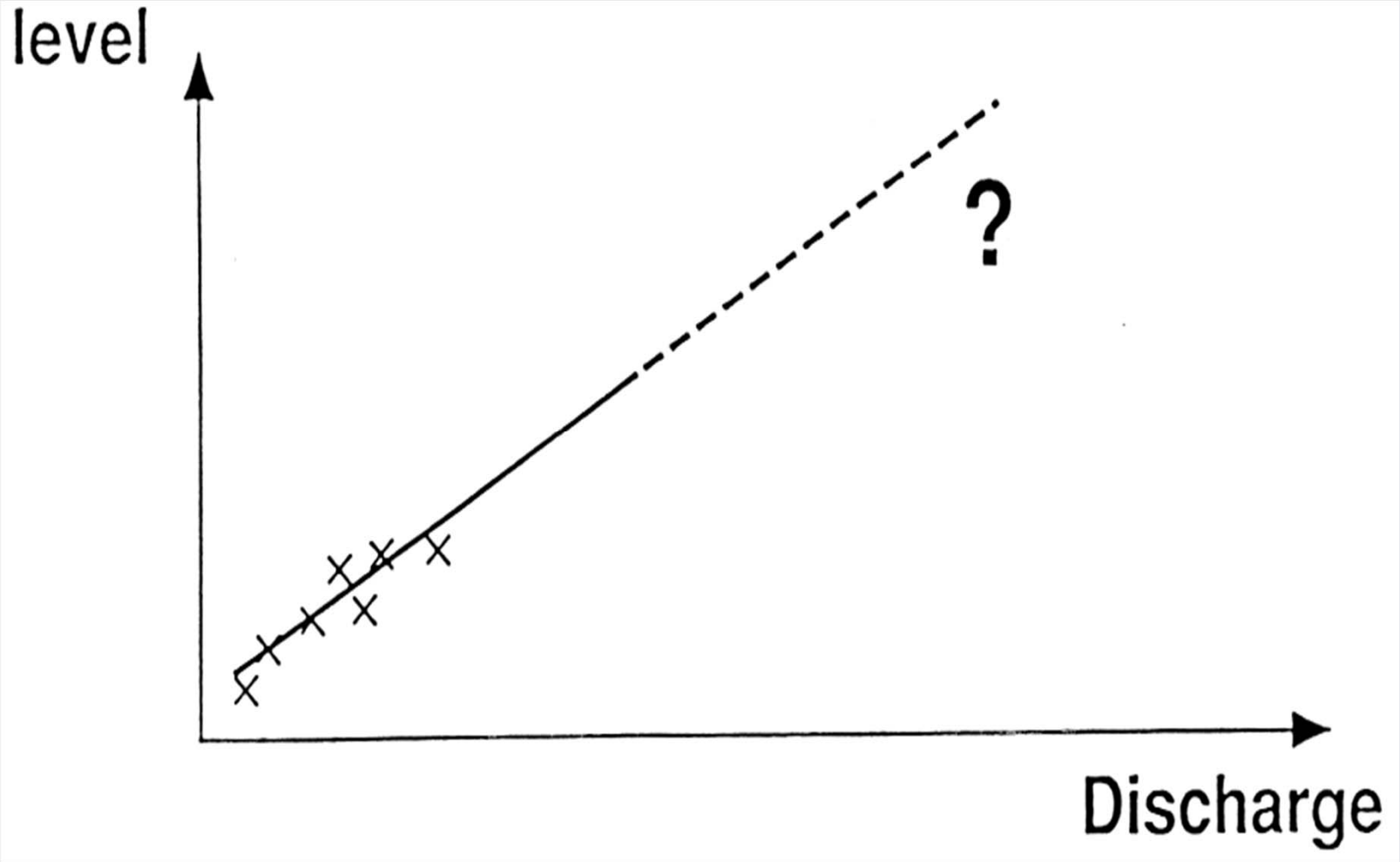
> Discharge is less than normal flow on falling flood stage

> Biggest impacts for rapidly varying, out-of-bank flows and wide flood plains

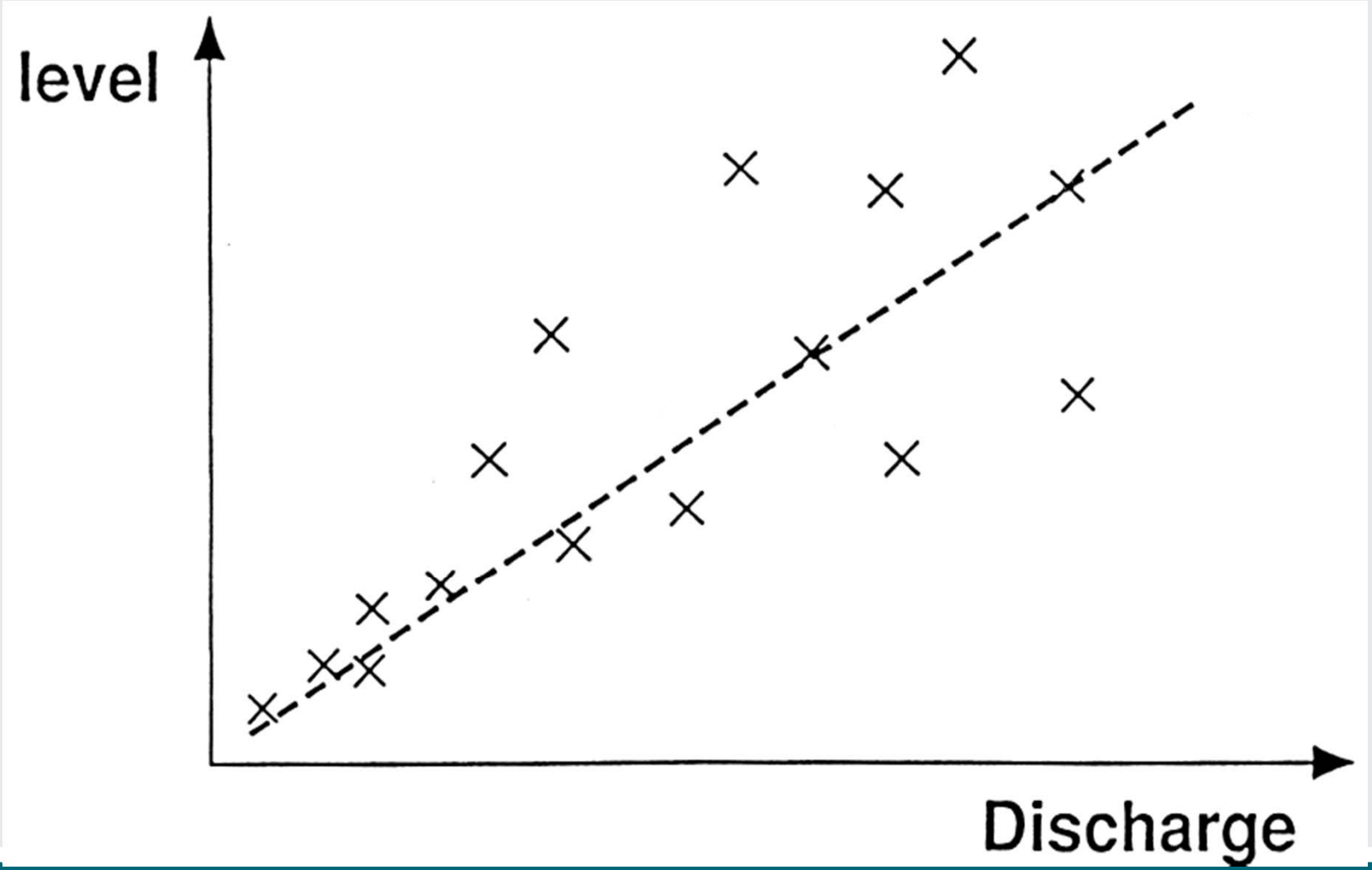
Rating curves
Practical difficulties

- > Extrapolation above the highest gauging
- > Backwater from a downstream control
- > Bypass flow under flood conditions
- > Out of bank section geometry
- > Seasonal changes (growth and decay of vegetation)
- > Morphological effects (mobile bed, alluvial friction)

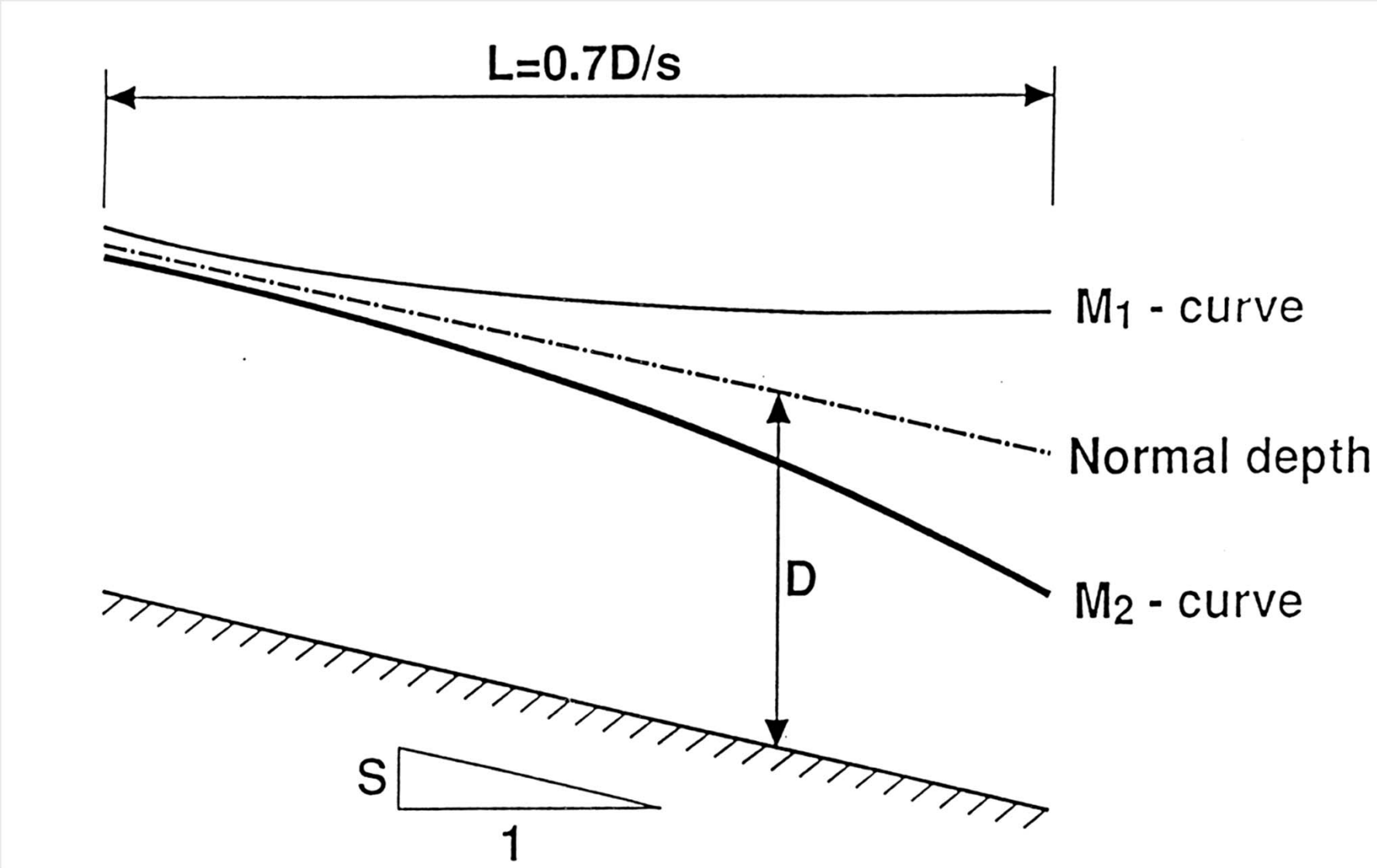
Rating curves
No data for high flows



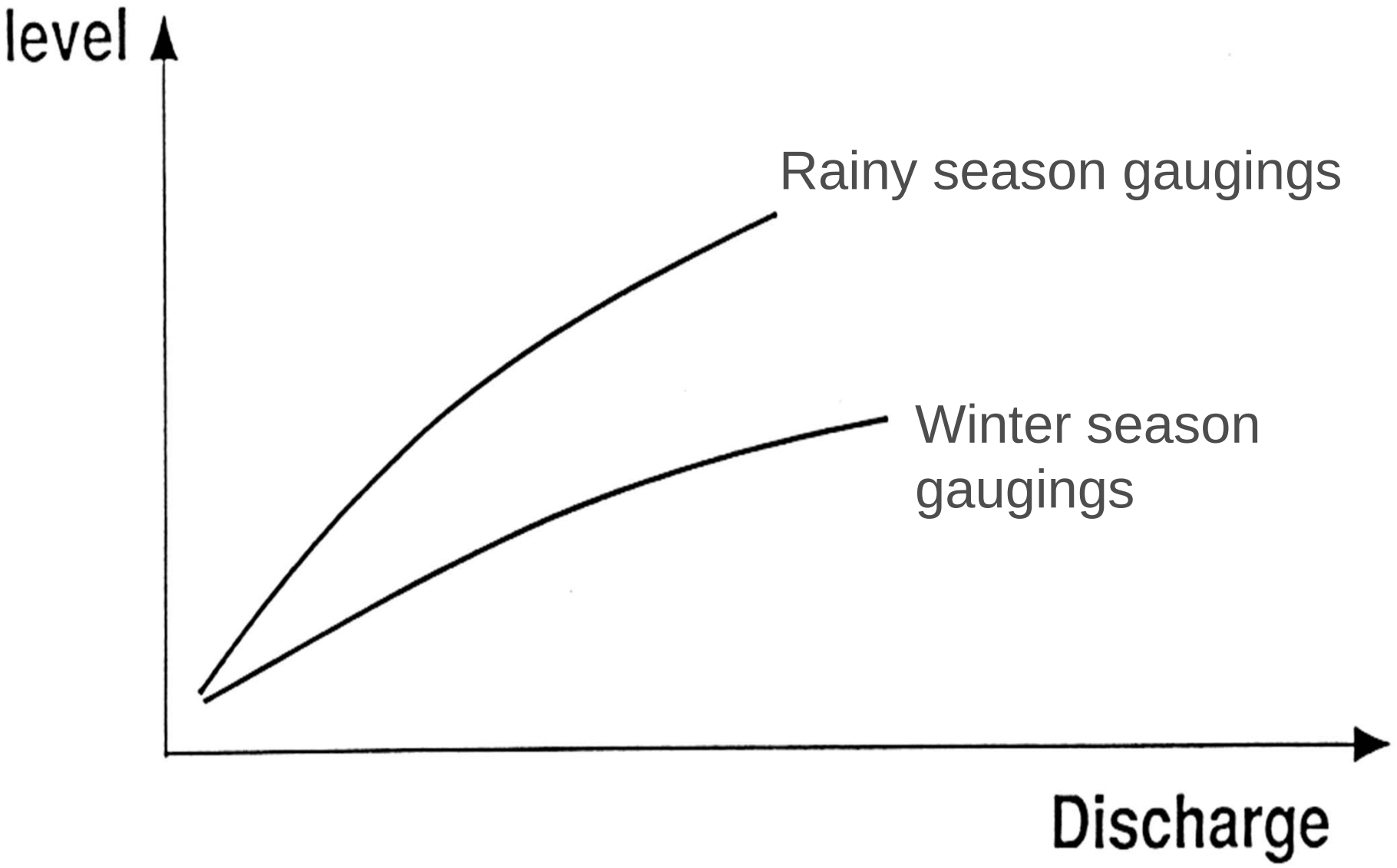
Rating curves
Backwater influence



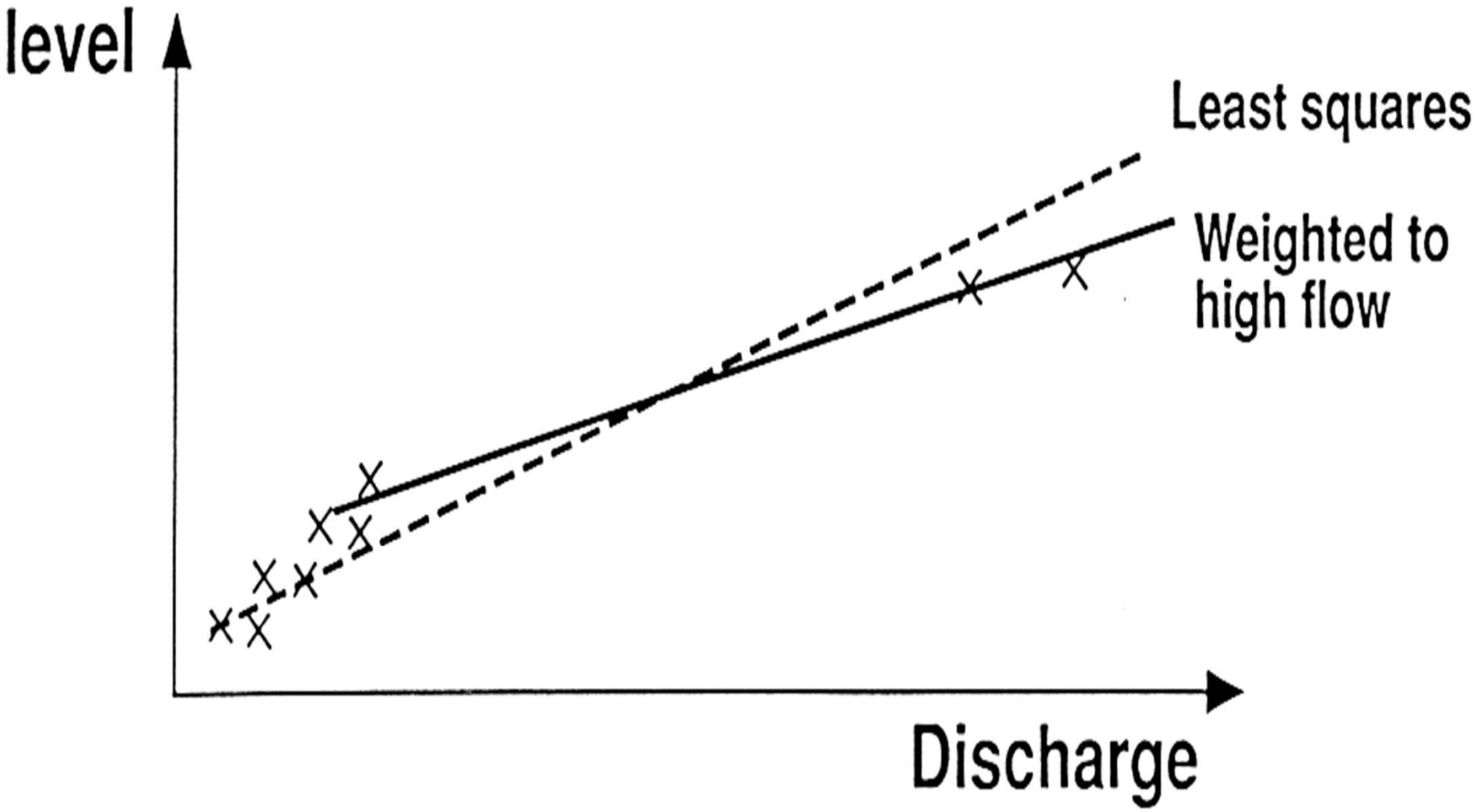
Rating curves
Backwater length



Rating curves
Seasonal influence



Rating curves
Fitting methods



Rating curves
Extension and fitting methods

> Use multiple equations

> Each has a defined range of stage

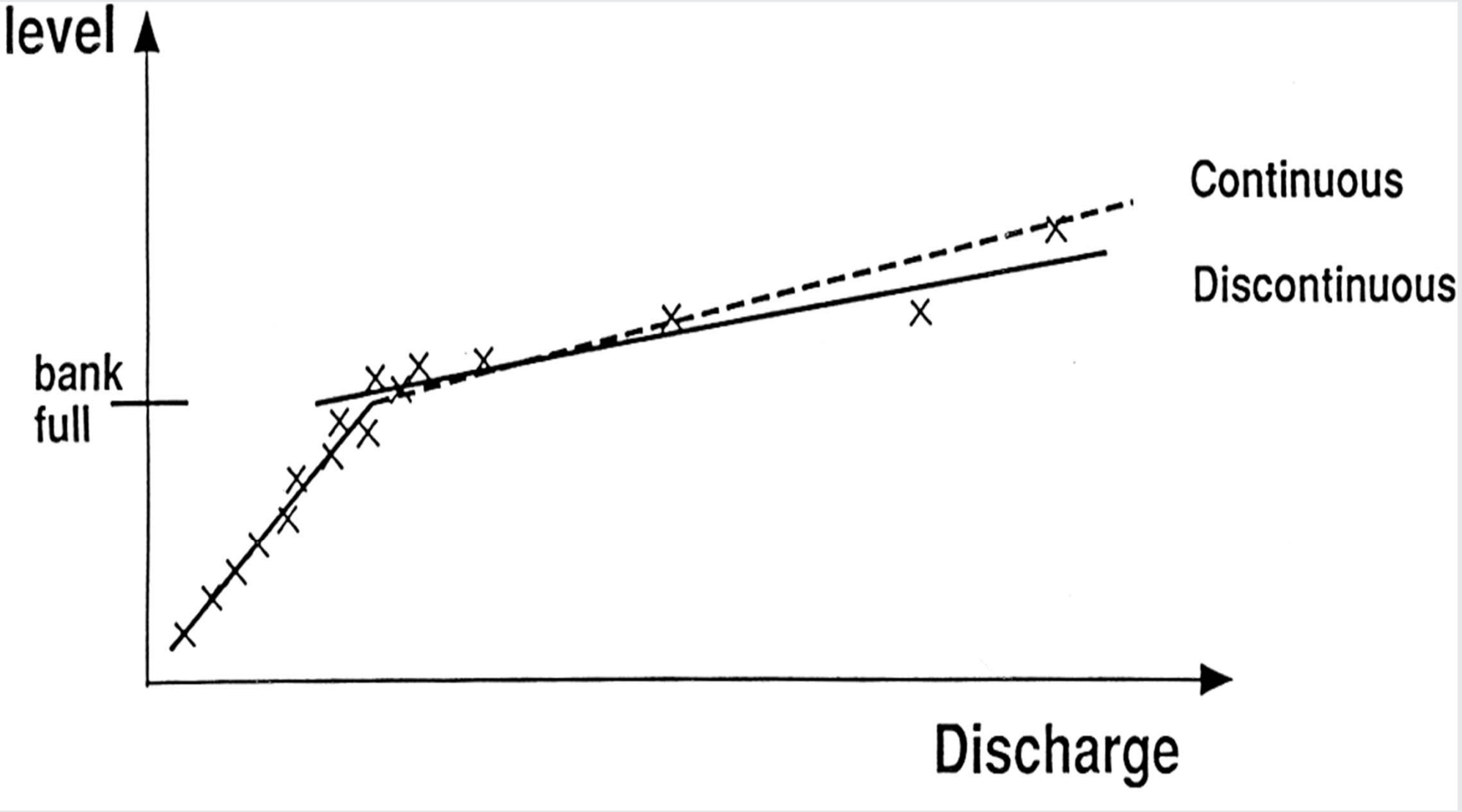
> Identify physically significant transitions

> Break point at bankfull stage ?

> Discontinuity at bankfull stage ?

> Analyse out-of-bank flow separately?

Rating curve extension
Out of bank fitting



Plot rating curves

Rating before flood

Flow (m^3/s)	Stage (m)
0.0	0.0
6.4	0.4
16.8	0.8
30.5	1.2
45.4	1.6
62.8	2.0
81.8	2.4
102.4	2.8
126.6	3.2

Rating after flood

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Why could the rating curve have changed after the flood?

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Any questions?

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