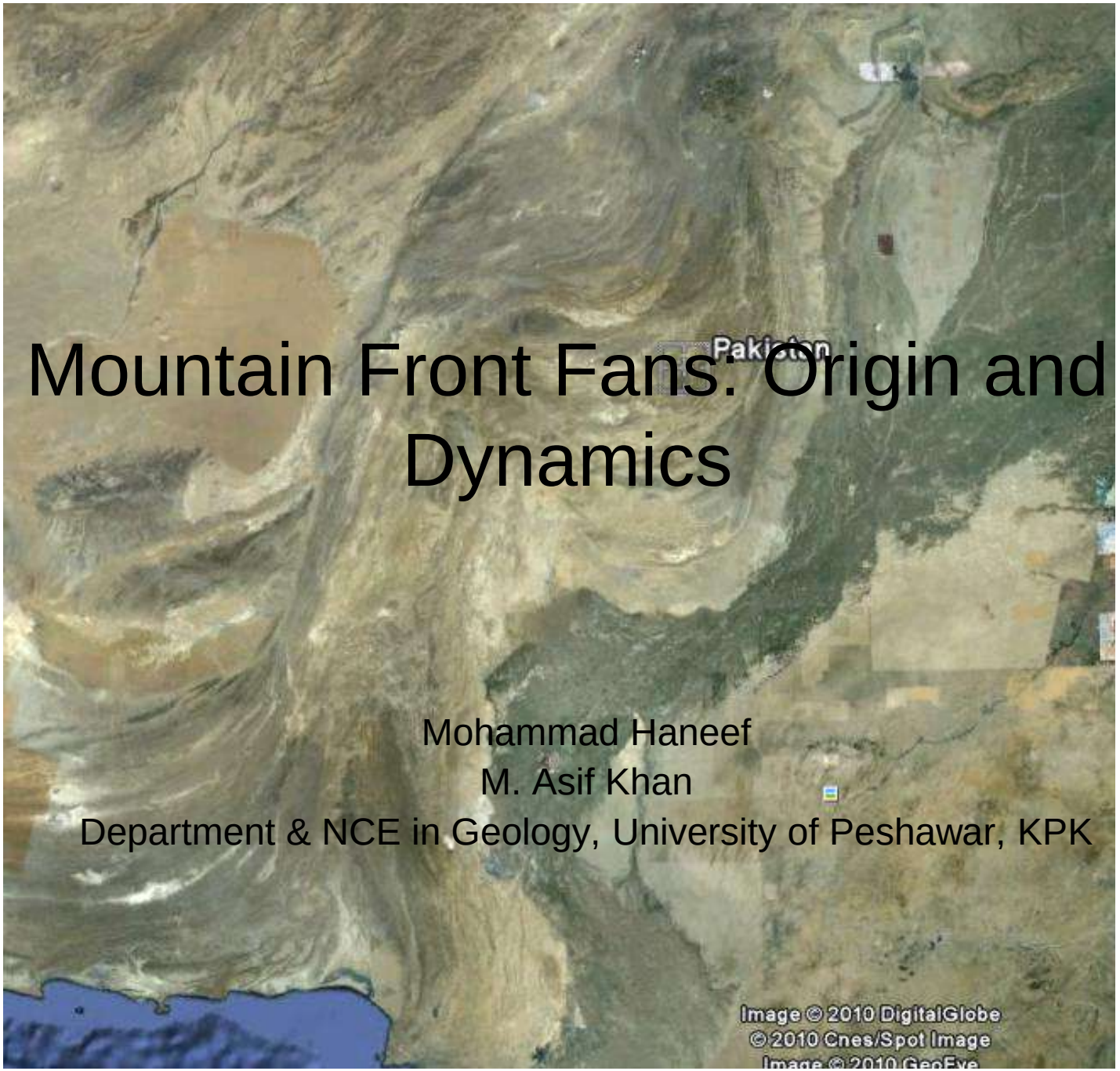
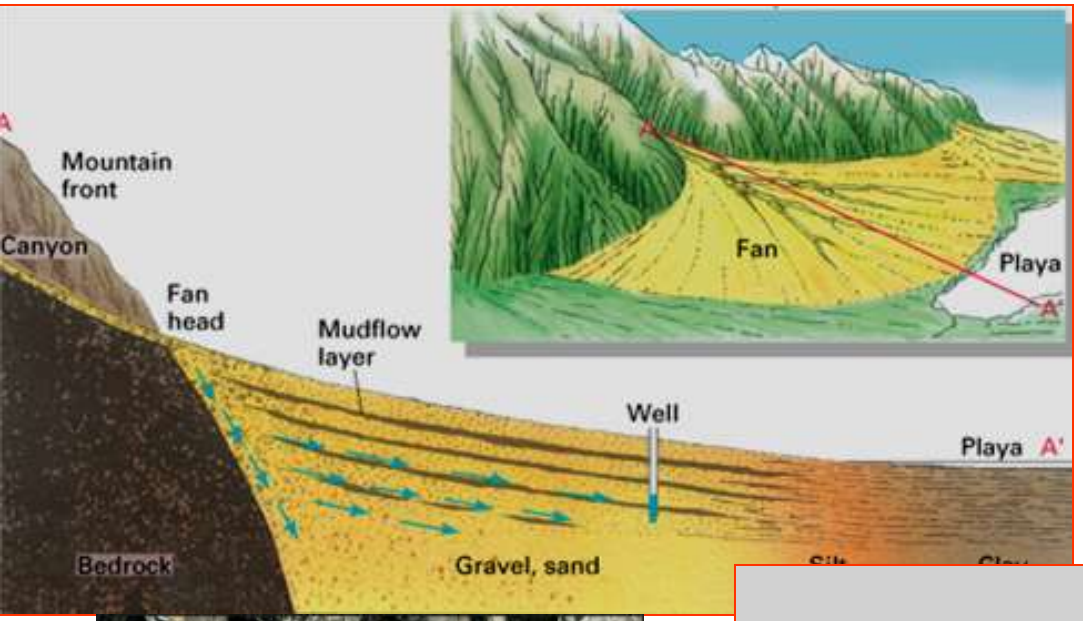
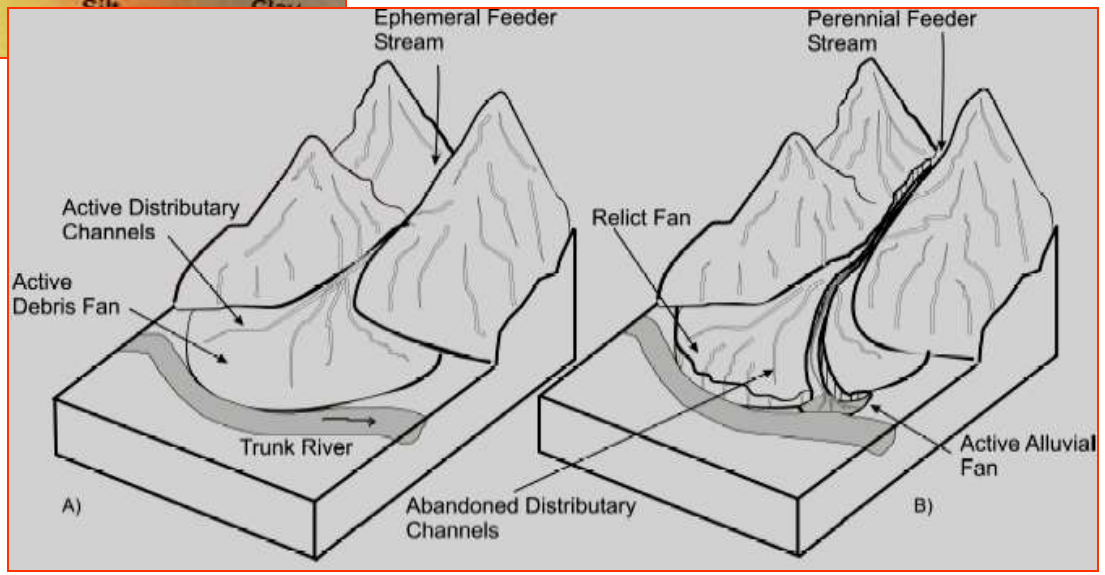


Mountain Front Fans: Origin and Dynamics

Mohammad Haneef
M. Asif Khan
Department & NCE in Geology, University of Peshawar, KPK

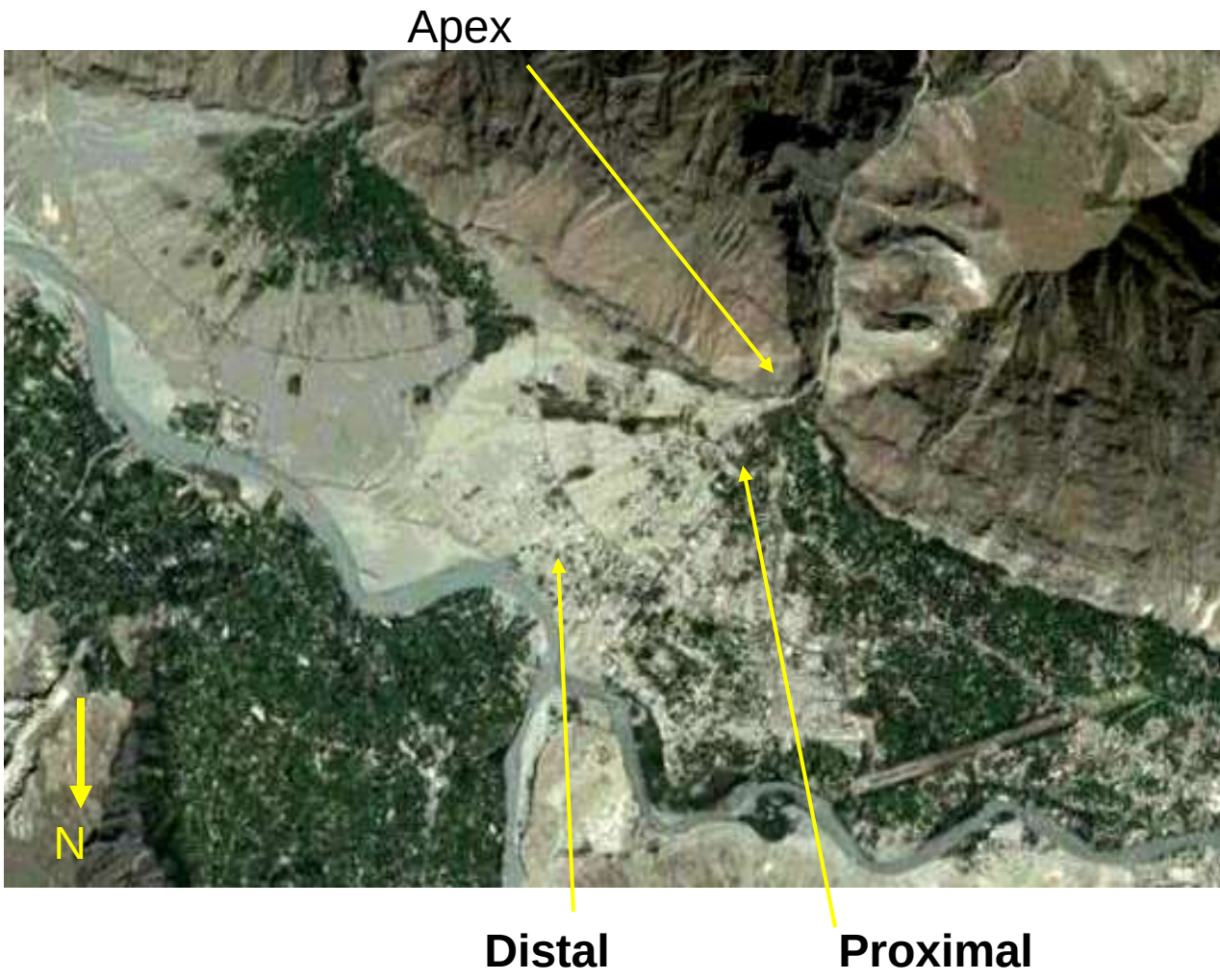
Alluvial fans are gently sloping, fan-shaped landforms common at the base of mountain ranges in arid and semiarid regions





Alluvial Fans Characteristics

- The intersection point or apex of the active fan is where the feeder channel ends and sediment flows lose confinement and can spread laterally, thin, and deposit sediment
- Proximal part of fan
- Highest velocity and greatest flow depth and deposit thickness,
- most destructive.
- Vertically stacked debris-flow lobes and levees that result in thick and coarse deposits that exhibit the roughest surface on the fan
- Distal part of fan,
- Generally lower velocities, shallower flow depths, and deposits,
- Less destructive



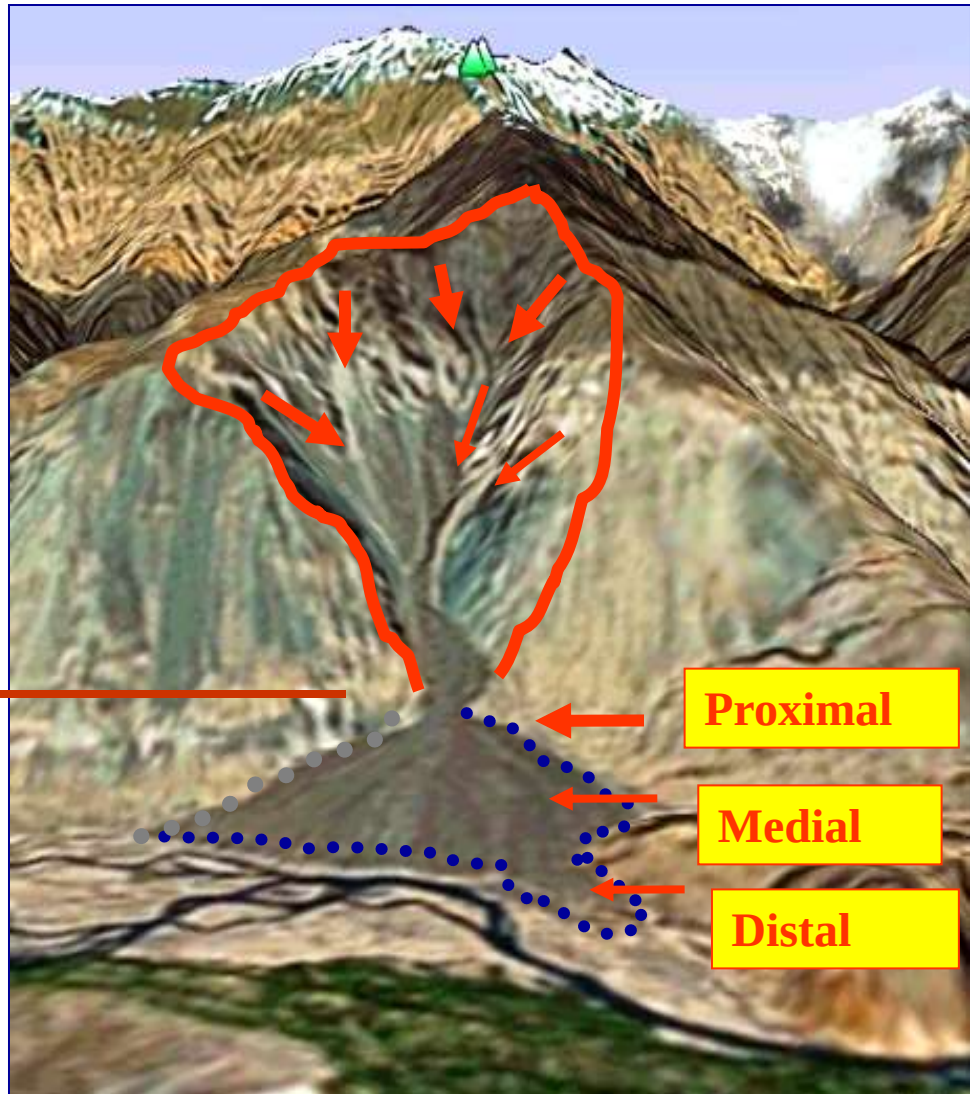
ANATOMY OF FAN

DRAINAGE BASIN

- **Weathering**
- **Gulley Erosion**
- **Mass Wasting/ Slope Failures**
  - **Landslies**
  - **Talus Cones/Aprons**
  - **Slumps/avalanche**
  - **Creep**

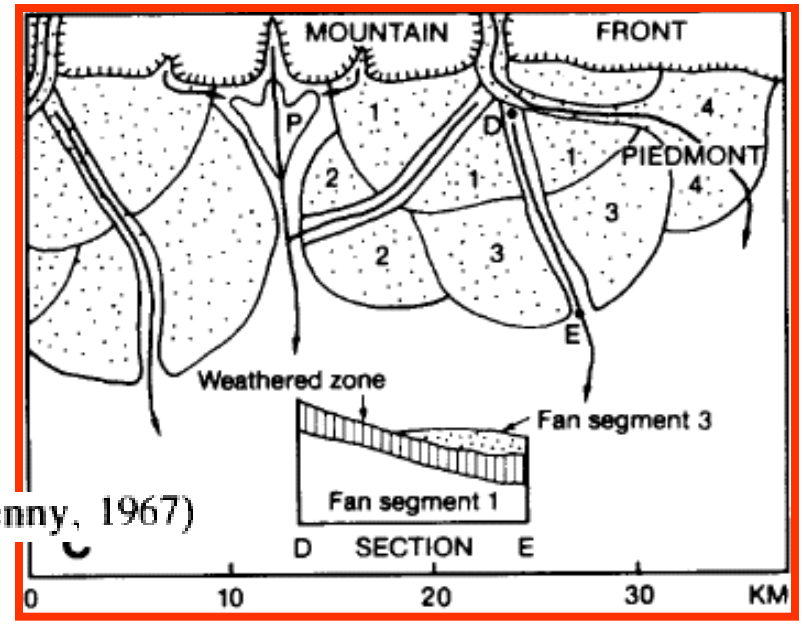
DEPOSITIONAL BASIN

- **Alluvial/ Runout Fan**
- **Surface drainage**
- **Incised/Entrenched Channel**



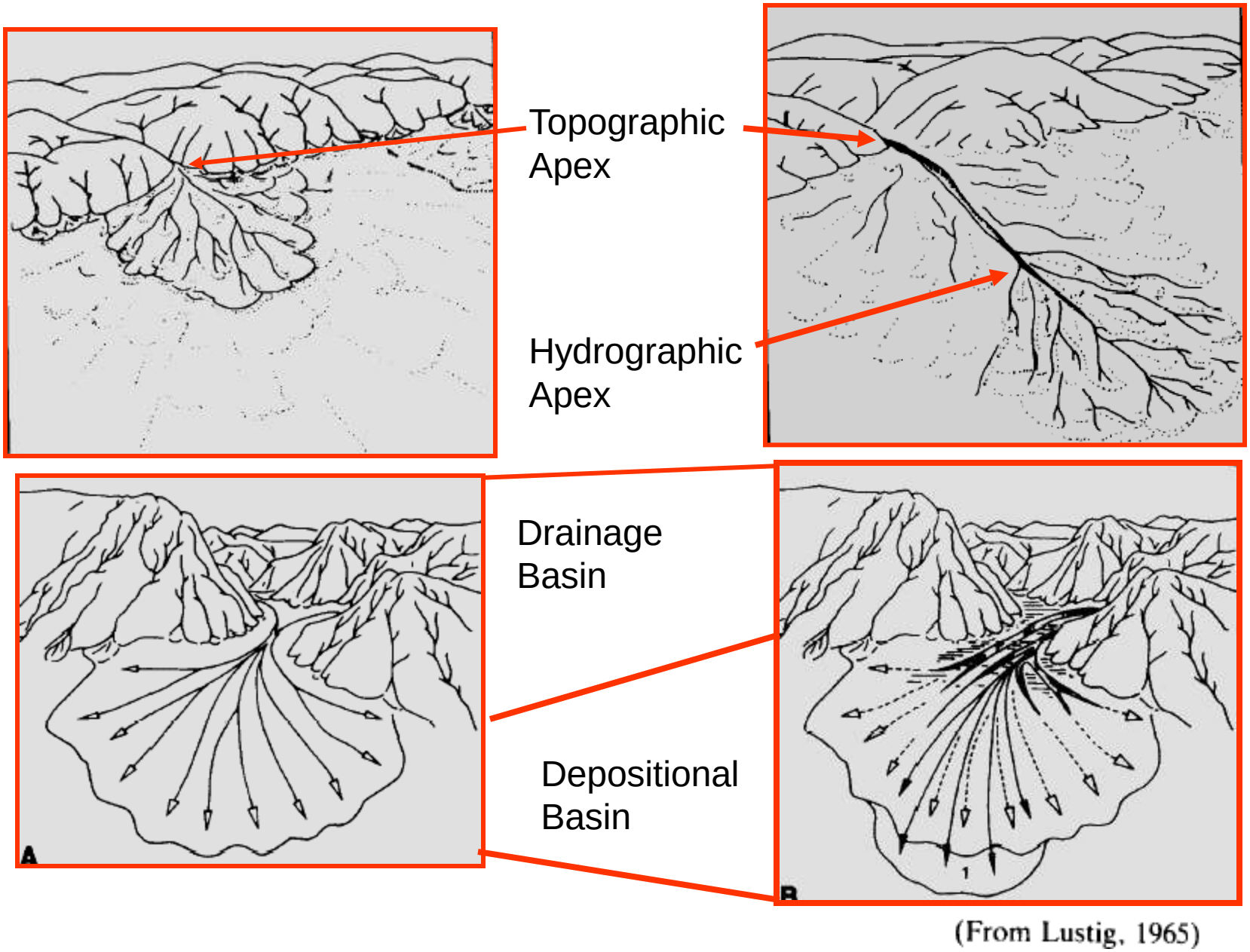
Genesis of Alluvial Fan

- 3 Conditions (Blair & McPherson, 2009)
- 1) Topographic Environment
- 2) Sediment availability at source to create a fan
- 3) Triggering mechanism to dislodge catchments sediments, Rainfall, Mass wasting processes and Earthquakes



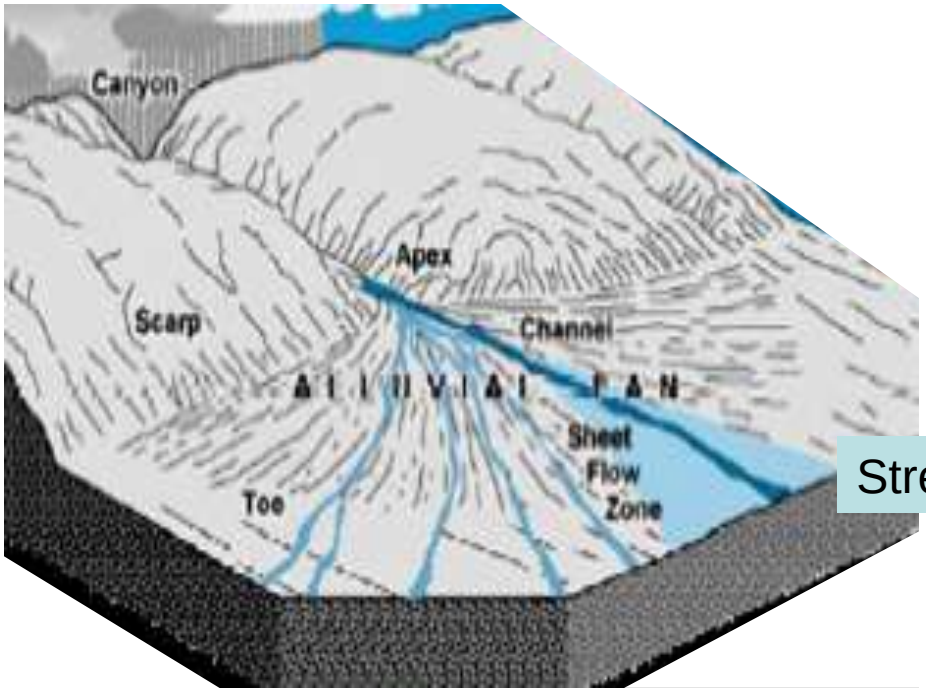
Denny, 1967)

- **Controlling Factors**
  - **Water Supply (Rain/Snow Melt/GLOF)**
  - **Basin Relief**
  - **Channel Gradient**
  - **Bedrock & surfacial Geology**
  - **Sediment Supply**
- **Flow Dynamics**
  - **Steep Barren Slopes (Flow velocity Control)**
  - **Flow impediments (Channel Choking/ Damming**
  - **Pore Pressure (Capability to transport coarse debris)**



(From Lustig, 1965)

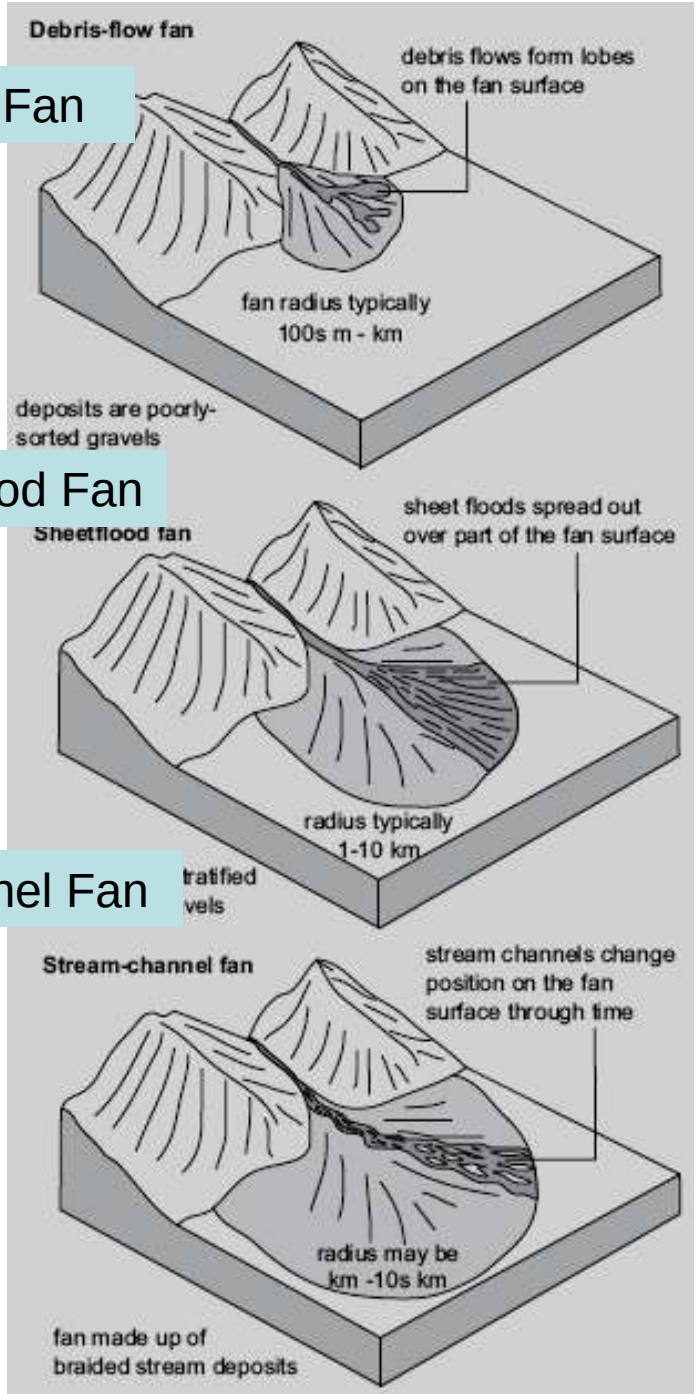
Cones of detritus form at a break in slope as sediment –laden stream exit the drainage basin.



Debris Fan

Sheetflood Fan

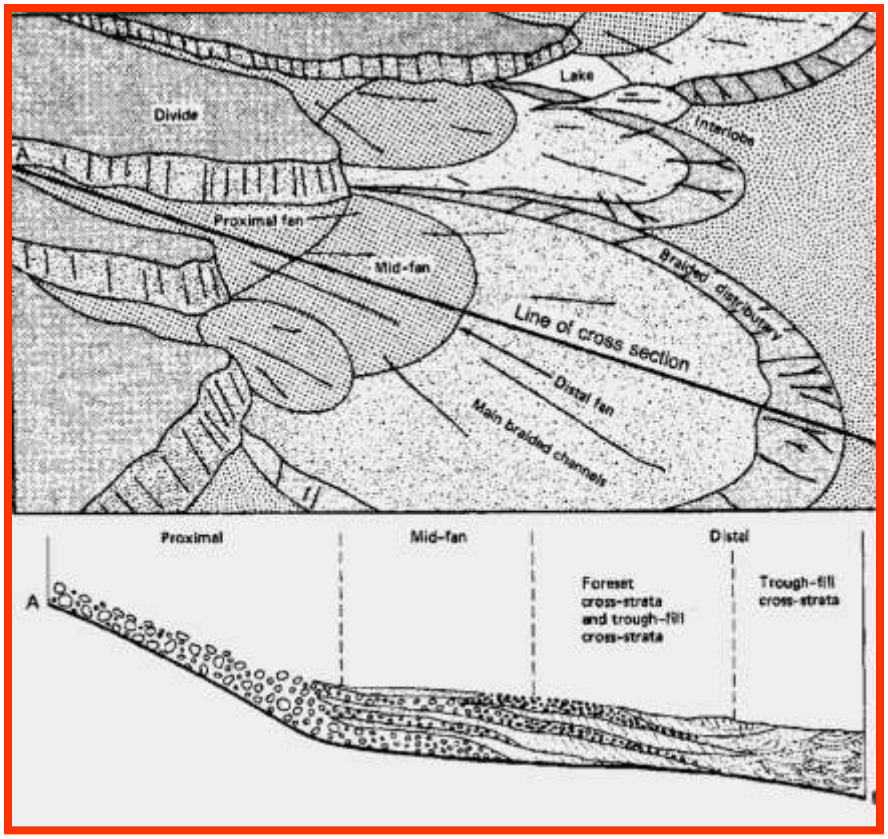
Stream Channel Fan

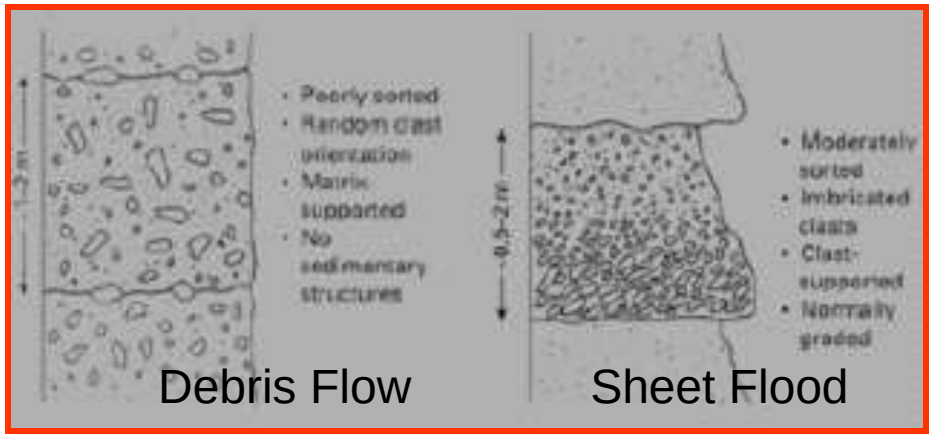


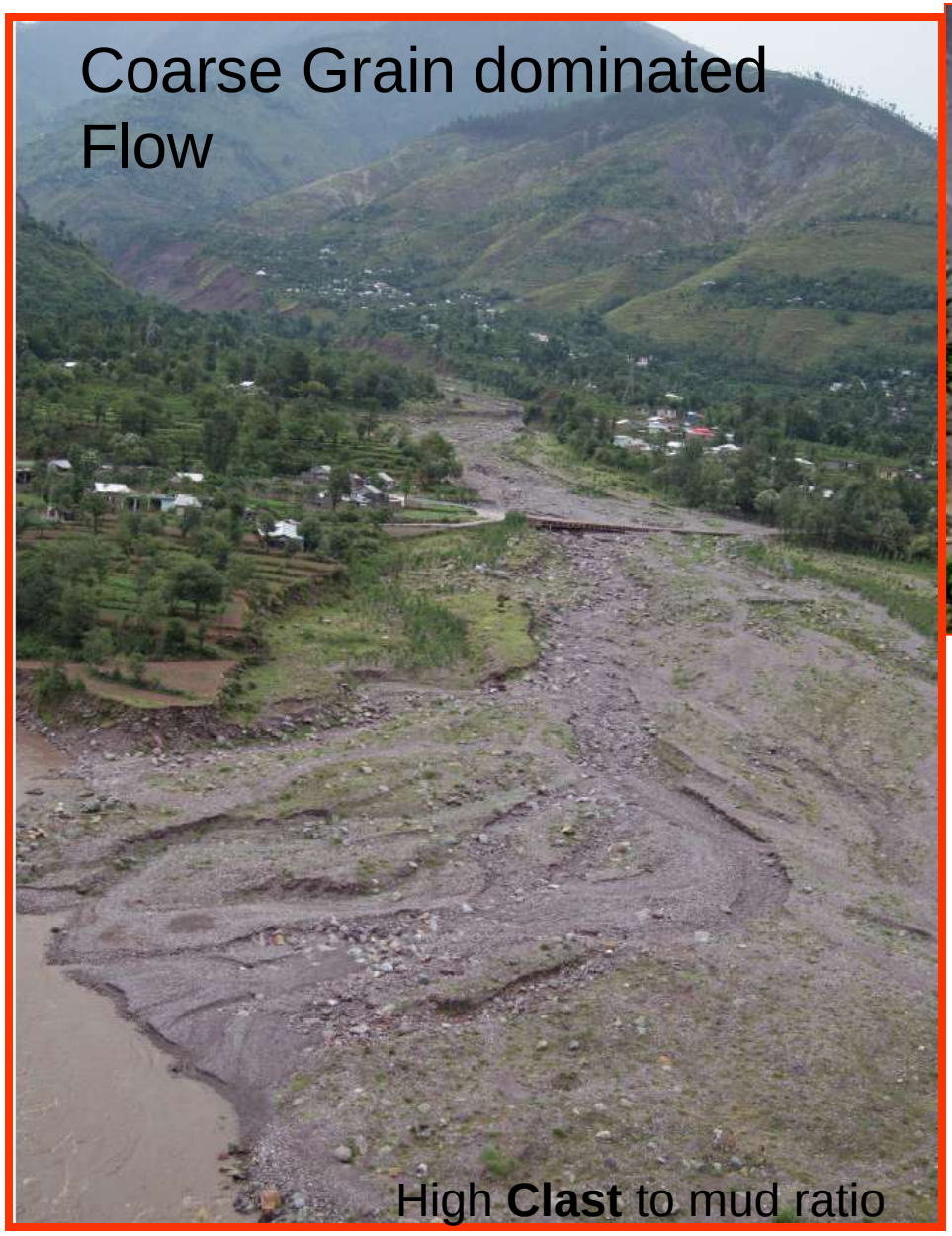
Sedimentology of Fan

Decreasing

- Sediment Grain size
- Fan Thickness
- Gradient
- Distributary channels






Coarse Grain dominated Flow
High **Clast** to mud ratio


Mudflow Fan

DEBRIS FLOW

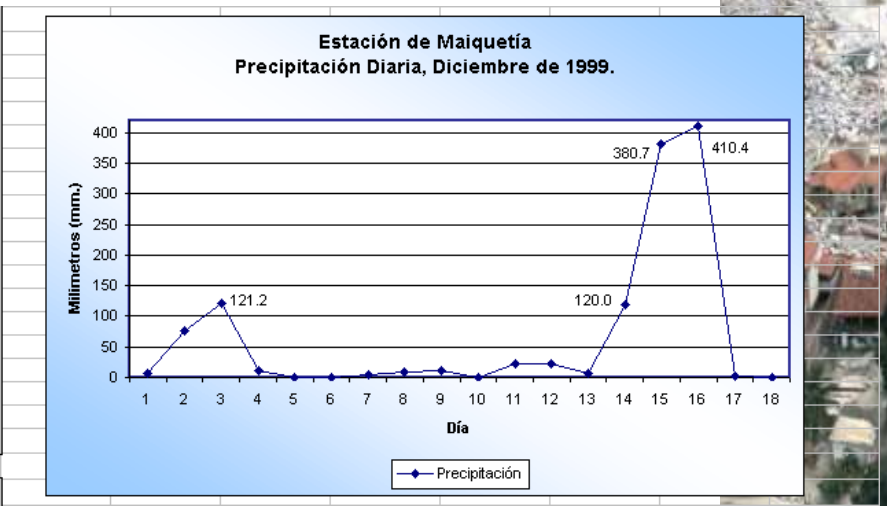
- Debris flow - a mixture of fine (clay, silt and sand) and coarse (gravel, cobbles and boulders) materials with a variable quantity of water.
- Mixtures often behave like viscous "slurries" as it flow down slope.
- High density, 60% to 80% by weight solids and may be described as being analogous to "wet concrete" (Hutchinson, 1988).
- Attain high flow velocity

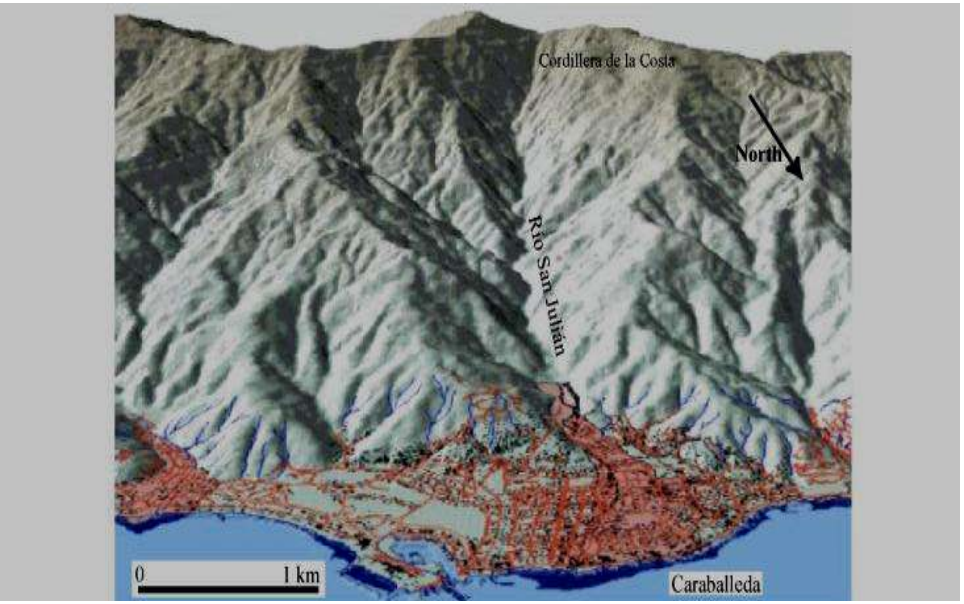
Movement Rate	Velocity Class	Velocity Limits	Rate (mm/sec)	Debris Flow Range
Extremely rapid	7	5m/sec	5×10^{3}	
Very rapid	6	3m/min	50	
Rapid	5	1.8m/hour	0.5	
Moderate	4	13m/month	5×10^{-3}	
Slow	3	1.6m/year	50×10^{-6}	
Very slow	2	16mm/year	0.5×10^{-6}	
Extremely slow	1			

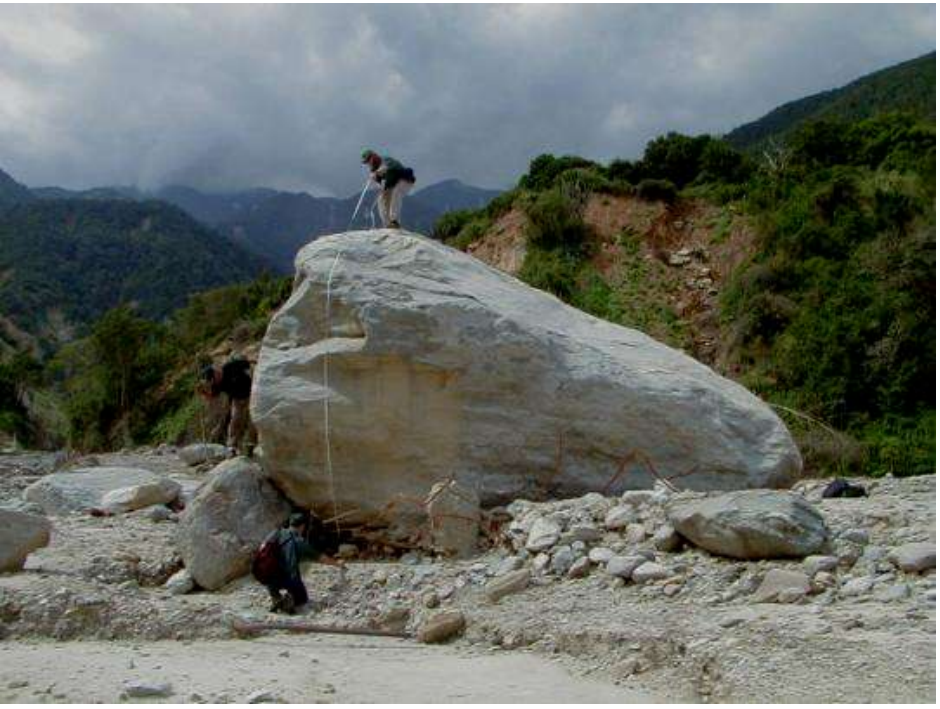
DEBRIS FLOW HAZARD

Venzuella Debris Flow- 1999

Deaths: 50,000
Persons affected: 331,164
Homeless: 250,000
Disappeared persons: 7,200
Housing units affected: 63,935
Housing units destroyed: 23,234

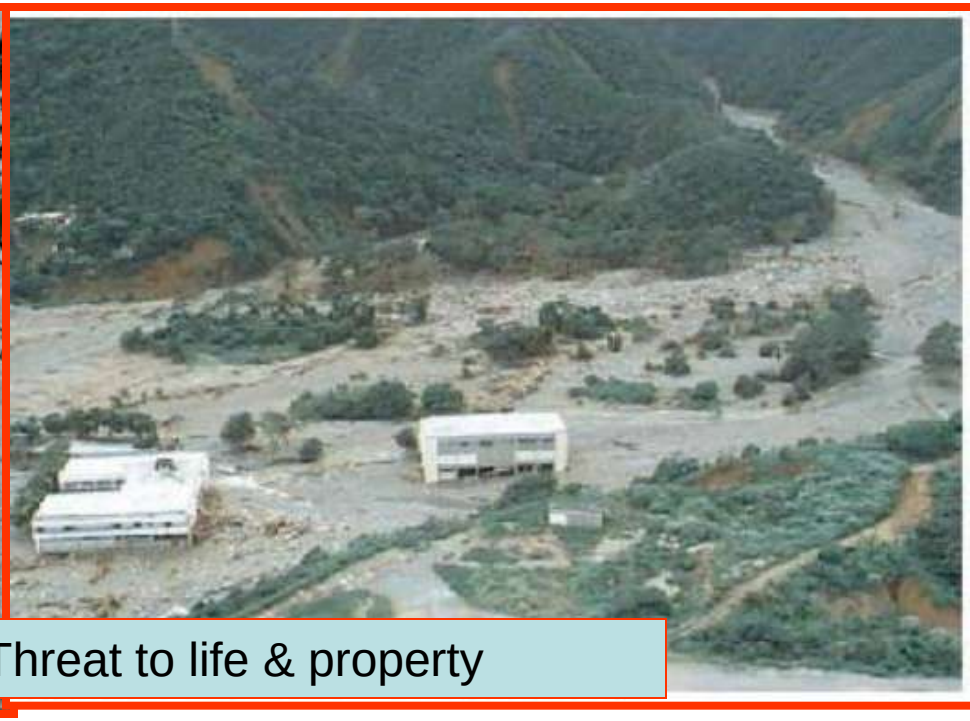



Cordillera de la Costa
North
Río San Julián
0
1 km
Caraballeda



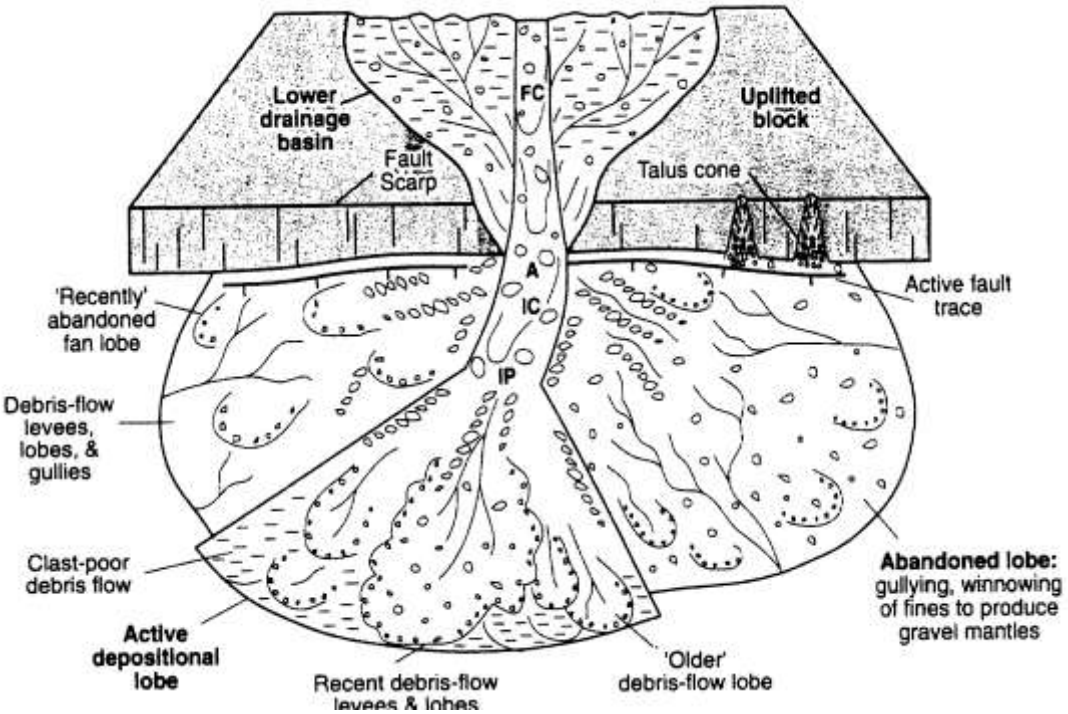
Alluvial Fan Flooding

- Short duration, heavy rains
- Non - Channelized flow
- Channel overtopping/spill over/choked channels
- High velocity streams with coarse sediment mobilization

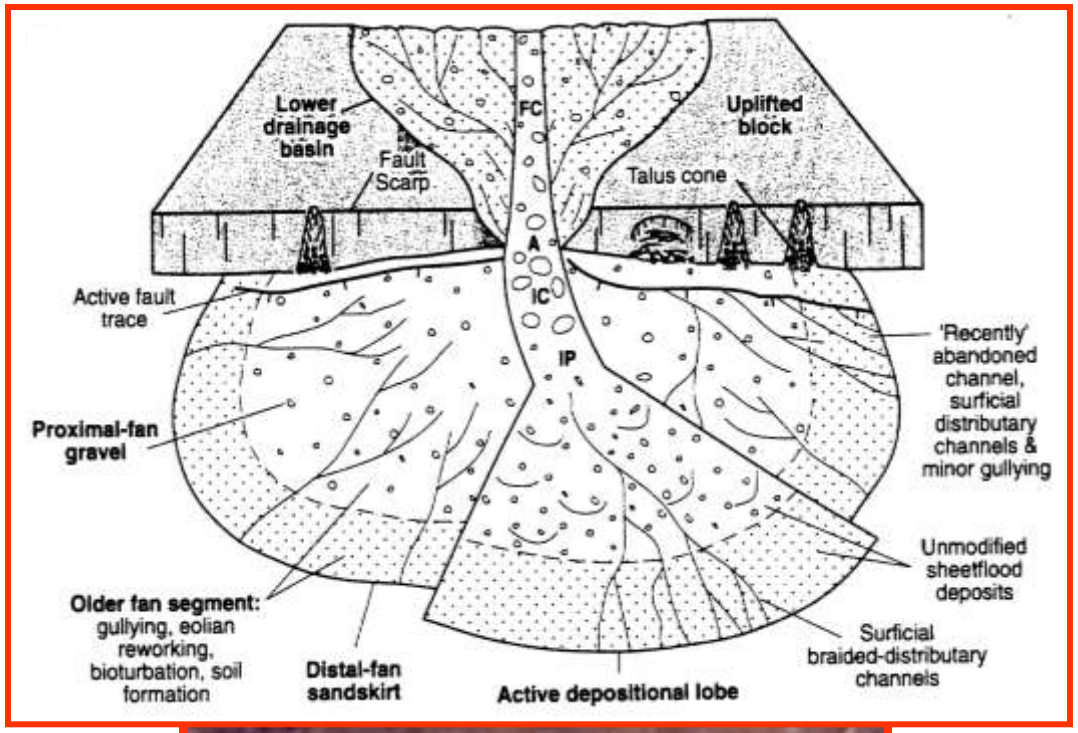


Catastrophic – Threat to life & property

Debris Flow dominated Fan



Sheet flood Dominated Fan



Intrastratified clast-rich and clast -poor sheet flood deposits

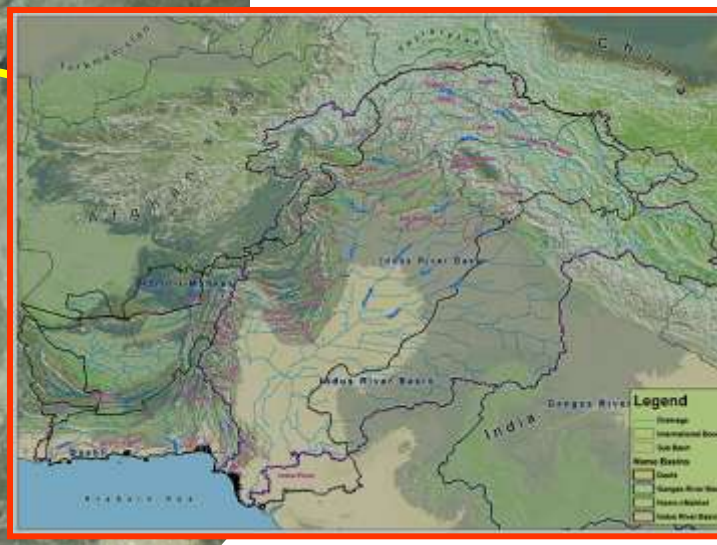
Classification of Debris Fans

- Immature fan (Unstable)
  - **Steep, gradient stream profile**
  - **Non-channelized, surface drainage**
  - **High angle slopes (free slope) in the catchment area.**
  - **High clast to matrix ratio sediments**
- Mature Fan (Partially Stabilized)
  - **Moderate to gentle gradient stream profile**
  - **Drainage mainly through deeply incised straight to tortuous channels**
  - **Large catchment area with moderate to gentle slopes**
  - **Few feeding streams with long stretches in lowlands**
  - **High matrix to clast ratio. High input of clay, silt and sand.**
- Highly Mature Fan (Stabilized)
  - **Gentle stream profile (low gradient stream)**
  - **Surface drainage confined to deeply entrenched channels.**
  - **Few, large sediment feeding channels**
  - **Fan sediments with high matrix to clast ratio.**
  - **Thick vegetative cover of rooted plants**

Piedmont Plains of NWF regions of Pakistan

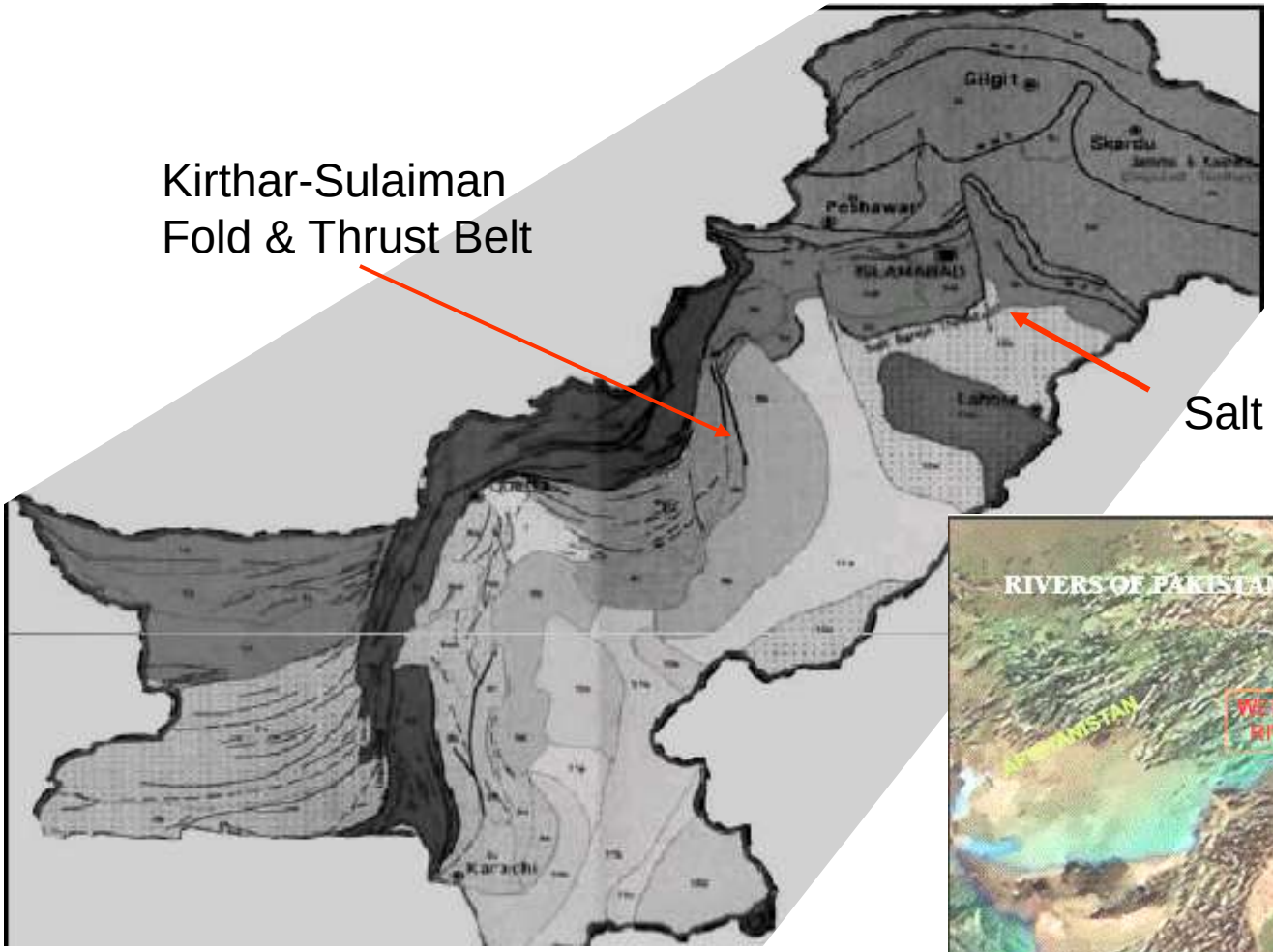
Area 200,000 km2

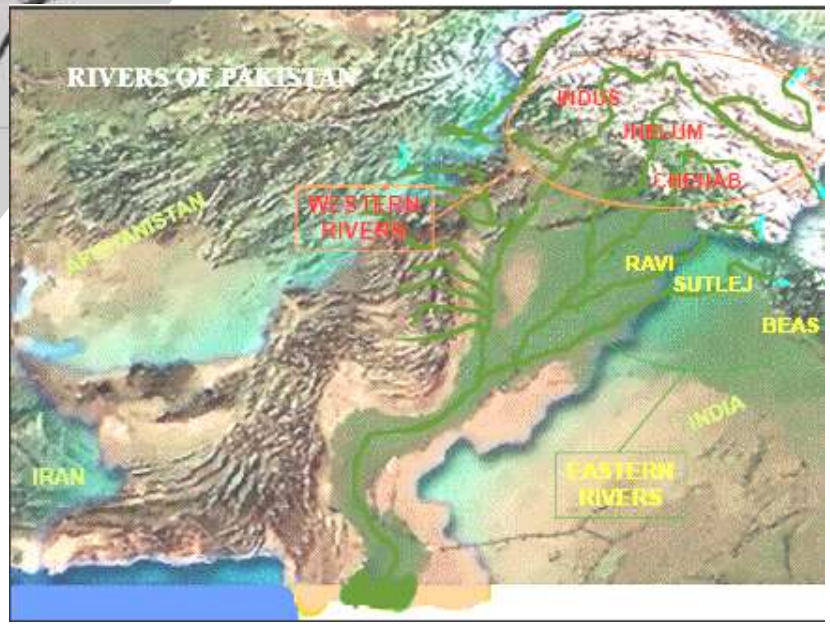
50-200 km wide



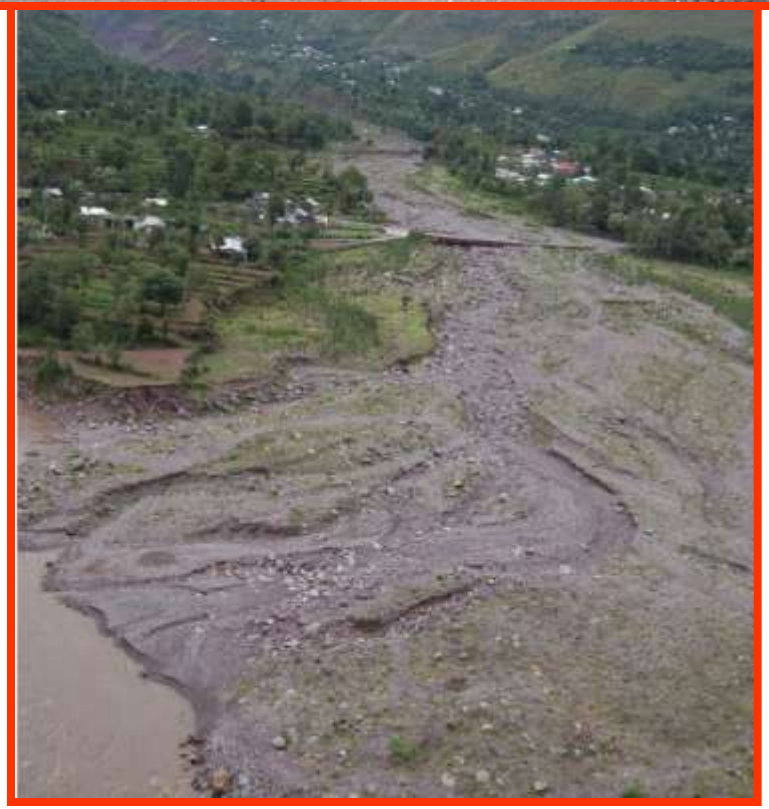
Kirthar-Sulaiman
Fold & Thrust Belt

Salt Range Thrust





Major Faults




Mountain front fans


Google

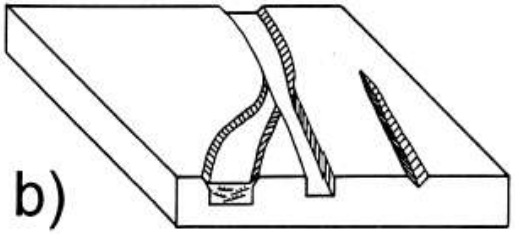

Drainage
through
settlement
& cultivated
areas
Google


Drainage
on the fan
Google

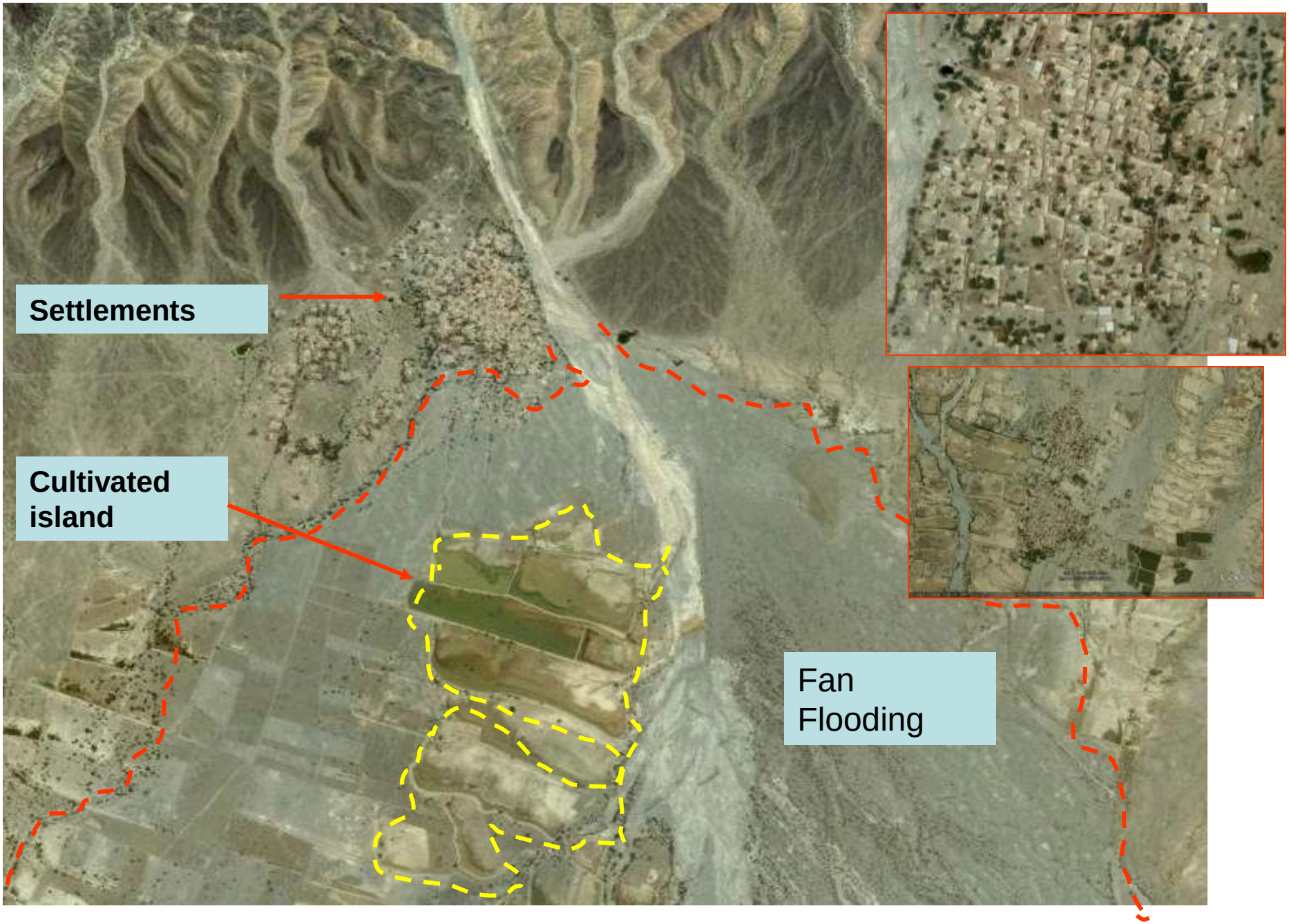
Cultivated fields on the piedmont plain

Next slide

Channel Avulsion



Abandoned fan with poorly developed shallow, branching channels


Settlements
Cultivated island
Fan Flooding

Flooded part of fan


Mixed Flow


Debris flow


Sheet flood

Thank you