SCS Toolbox — Module Differences and Parity Notes (QGIS vs ArcGIS)

1. Introduction

This document summarises the conceptual and functional differences between the QGIS-based SCS Toolbox (Modules 1–4a) and the original ArcGIS/ArcPy implementation.

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2. Terminology and Conventions

- **Centreline**: British spelling standardised to *centreline*.
- **union_noholes**: Union of channel polygons with internal holes removed.
- **EA**: Erosion–Accumulation processes (Module 3).
- **Assemblage (Module 4a)**: EA-based multi-period floodplain composite using chronological overwrite.
- **DED / HACH**: Height Above Channel (derived elevation).
- **CHM**: Canopy Height Model.

Terminology is harmonised across modules and consistent with the updated QGIS workflow.

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3. Module-by-Module Overview

3.1 Module 1 — Centreline Extraction

Summary
The modules are conceptually equivalent—both generate centrelines from channel polygons in per-year and union/segmentation modes—but differ in algorithms, geometry cleaning, and output handling.

QGIS vs ArcGIS

- QGIS reimplements ArcGIS M1 using GRASS skeletonisation or a QGIS Voronoi-clip fallback.
- Skeletonisation differs subtly from ArcGIS's Thiessen-based medial axis.
- QGIS requires file-backed intermediates (SHP) due to Windows memory constraints.
- QGIS integrates automated geometry repair (fixgeometries, buffer(0)).
- Output is standardised as GeoPackage (centro_YYYY0101.gpkg, SegCenterline.gpkg).

3.2 Module 2 — Segmentation

Summary
The modules are conceptually equivalent—both divide a centreline into equal-length intervals and generate Thiessen/Voronoi segments clipped to the channel union—but differ in how unions are sourced and how joins are handled.

QGIS vs ArcGIS

- QGIS v10 assumes Module 1 has already produced a clean **union_noholes**, and does not rebuild it.
- QGIS discovers SegCenterline automatically rather than receiving it as an explicit input.
- Voronoi polygons use guard points and union healing (zero-distance buffer) for robustness.
- Attribute joins (ID_SEQ, Distance) use fallback predicates to avoid empty joins.

3.3 Module 3 — EA Calculation

Summary
The modules are conceptually equivalent—both compute erosion, deposition, islands, and migration direction/rate between successive channel epochs—but QGIS adds greater geometry robustness and finer class distinctions.

QGIS vs ArcGIS

- Uses explicit polygon unions and coalescing logic to classify change.
- "Stable" classes refined into: stable_channel, stable_floodplain, inactive_floodplain.
- Islands handled consistently with ArcGIS but with more robust geometry checks.
- All intermediates are file-backed GPKGs to avoid FID corruption and memory crashes.
- Outputs consolidated into a single GeoPackage per period.

3.4 Module 4a — Floodplain Assemblage, HACH and CHM

Summary
ArcGIS Module 4 builds a channel-based Floodplain Age Map (FAM), whereas QGIS Module 4a replaces this with an EA-based floodplain assemblage using chronological overwrite and adds equivalent HACH/CHM surfaces and segment statistics.

3.4.1 Conceptual Shift: FAM → Assemblage

- **ArcGIS Modul4** constructs a single FAM layer by unioning channel polygons and assigning the youngest occupation date.
- **QGIS Module 4a** constructs a composite floodplain **assemblage** from multiple EA layers:

    - Accepts up to 15 EA layers (Module 3 outputs).
    - Auto-sorted by end-date parsed from the Period field.
    - Uses a strict **newest-wins difference-plus-merge chain**.
    - Optionally preserves stable_floodplain units via a controlled carry-forward rule.
- Final product includes:
    - EA_Class_final
    - Period_final
    - Year

Thus, QGIS 4a encodes both *process* and *temporal* information in a single composite polygon layer.

3.4.2 HACH (DED) Computation

- ArcGIS uses *TopoToRaster* to interpolate a thalweg trend.
- QGIS uses **GDAL IDW (gdal_grid)** with explicit control of extent and resolution.
- DEM is clipped to a buffered AOI derived from the assemblage.
- Result is DED_m5.tif, conceptually equivalent to HACH.

3.4.3 CHM Computation

- ArcGIS: DSM – DEM, masking values ≤0.
- QGIS: DSM – DEM_clipped, setting ≤0 to NoData (-9999).
- Output: veget_CHM_m5.tif.

3.4.4 Segment-Based Statistics

- ArcGIS joins FAM × segments × DED/CHM.
- QGIS intersects **assemblage × segments**, then applies qgis:zonalstatistics for DED and CHM.
- Outputs:
    - M5statistics_all.gpkg
    - M5statistics_hach.gpkg
    - M5statistics_FAMlike.gpkg

Statistics remain directly comparable (MIN, MAX, RANGE, MEAN, STD, SUM) even though the underlying polygon surface is assemblage-based rather than FAM-based.

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4. Relationship Between ArcGIS FAM and QGIS Module 4a Assemblage

- ArcGIS **FAM** encodes *absolute floodplain age* derived solely from channel occupation.
- QGIS **Assemblage** encodes *EA class + temporal order* (not absolute age).
- Assemblage can be *interpreted* temporally via Period_final, but it is not strictly a FAM.
- Assemblage offers richer information: stability, reworking class, and temporal sequence.
- FAM and Assemblage are therefore **related but not identical analytical products**.

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5. Using Assemblage with EA and Segments

- Assemblage × EA intersections allow identification of long-term stability vs recent reworking.
- Assemblage × segments supports longitudinal analysis of floodplain processes.
- Assemblage can validate EA sequencing (e.g., whether deposition overlaps older surfaces).
- Combining CHM, DED, EA and Assemblage enables multivariate geomorphic interpretation.

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6. Summary of Parity and Key Differences

Equivalent (Conceptually)

- Channel-based union logic (Module 1) feeding into segmentation and EA.
- Midpoint-based segmentation (Module 2).
- Erosion/deposition classification rules (Module 3).
- Vertical products (HACH/DED, CHM) remain conceptually aligned with ArcGIS.

Different (Implementation-Specific)

- **Assemblage replaces FAM** as the main temporal floodplain surface.
- IDW interpolation replaces TopoToRaster.
- QGIS uses **file-backed GPKG outputs**, ArcGIS uses SHP.
- QGIS adds strict chronological overwrite logic and stable-floodplain carry.
- QGIS refactors PK fields and uses fallback spatial join strategies.

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7. Limitations and Considerations

- GDAL IDW produces smoother DED surfaces than ArcGIS TopoToRaster.
- QGIS in-memory layers are unstable under Windows; file-backed intermediates are mandatory.
- Attribute field names and behaviour differ between SHP and GPKG; normalisation is required.
- Assemblage is *not* a strict replacement for FAM; it represents a richer but different construct.

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8. Recommended Workflow Using Modules 1–4a

1. **Module 1** – extract centrelines and union_noholes.
2. **Module 2** – generate channel segments.
3. **Module 3** – compute EA processes per epoch.
4. **Module 4a** – build EA-based floodplain assemblage and HACH/CHM.
5. Combine Assemblage + EA + Segments for geomorphically integrated interpretation.