Int. J. Sci. R. Tech., 2026 3(1)
A Multidisciplinary peer-reviewed Journal
www.ijsrtjournal.com [ISSN: 2394-7063]

Original Article

Automating Multi-Directional Oblique Weighted Hillshade in QGIS with the Graphical Modeler

Moses Tangwam*, Caleb Mensah

Michigan Technological University

ABSTRACT

Hillshade remains one of the most popular cartographic techniques for visualizing terrain. However, using a single light direction often exaggerates slopes facing away from the light source while reducing detail on illuminated slopes. Multi-Directional Oblique Weighted (MDOW) hillshading minimizes these artifacts by combining multiple hillshades from different illumination azimuths into a single composite image. This methods paper explains a reproducible workflow for generating MDOW hillshade using the QGIS Graphical Modeler. The approach integrates all parameters, the input DEM, hillshade directions, and the raster calculator expression into a single reusable model. The model can be run on any DEM without manual reconfiguration, supports batch processing of tiled datasets, and can be extended or modified by other QGIS users. The paper targets GIS practitioners who regularly work with elevation data and seek to standardize their terrain-visualization workflows.

Keywords: QGIS, Graphical Modeler, MDOW hillshade, DEM, cartographic visualisation

INTRODUCTION

1. Background

Hill shading mimics how light interacts with a digital elevation model (DEM) from a hypothetical source, creating a greyscale image that enhances the perception of landforms (Horn, 1981; Yoeli, 1965). It produces a visual effect that helps improve understanding of terrain features. In many GIS projects, hillshade is the first product created from a DEM and often serves as the basis for subsequent cartographic work. Numerous derivatives, such as slope and curvature, are routinely derived from DEMs for geomorphometric analysis (Zevenbergen & Thorne, 1987). Standard hillshade, however, uses a single illumination azimuth (usually from the northwest) and altitude. This can cause directional bias, where slopes facing away from the light source become excessively dark, while illuminated slopes may lose micro-topographic detail. Multi-directional techniques address this by combining multiple hillshades generated from different azimuths. The MDOW approach uses oblique light directions and assigns weights to each, creating a more balanced, visually rich representation of terrain. Single-direction hillshades often overemphasize slopes facing away from the light source, causing noticeable directional artifacts. Multi-directional and oblique-weighted hillshades, like the Multi-Directional Oblique Weighted (MDOW) method originally popularized in the ArcGIS Terrain Tools toolbox, mitigate this issue by integrating hillshades from multiple azimuths (ESRI, 2015; Jenness, 2015). Recent work has also investigated alternative visualization methods that enhance or substitute traditional hillshade, especially for bathymetric and coastal data (Šolín et al., 2023). QGIS provides tools for MDOW hillshade, hillshade calculation, and raster algebra, but doing each step manually can be tedious and error-prone, especially when working with multiple DEM tiles. The QGIS Graphical Modeler allows users to connect algorithms into a single, custom workflow, enabling automated and reproducible creation of MDOW hillshades.

2. Data and software

The workflow is designed to be data-agnostic and can be applied to any single-band elevation raster with appropriate units and resolution. Typical inputs include national DEMs, LiDAR-derived surfaces, or SRTM-based products.

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

For this method, we used:

- **Software:** QGIS 3.44.3 with the Processing framework enabled.
- **Input:** DEM rasters in a projected coordinate system suitable for terrain analysis.
- **Processing tools:**
  - Raster terrain analysis → Hillshade (QGIS or GDAL implementation)
  - Raster → Raster calculator (GDAL)

The same steps can be adapted to other coordinate systems and DEM resolutions by adjusting the z-factor or scale parameters in the hillshade algorithm. The Graphical modeler in QGIS can be found by going to processing > Model Designer, and the Model Designer window should open as shown in Figure 1.

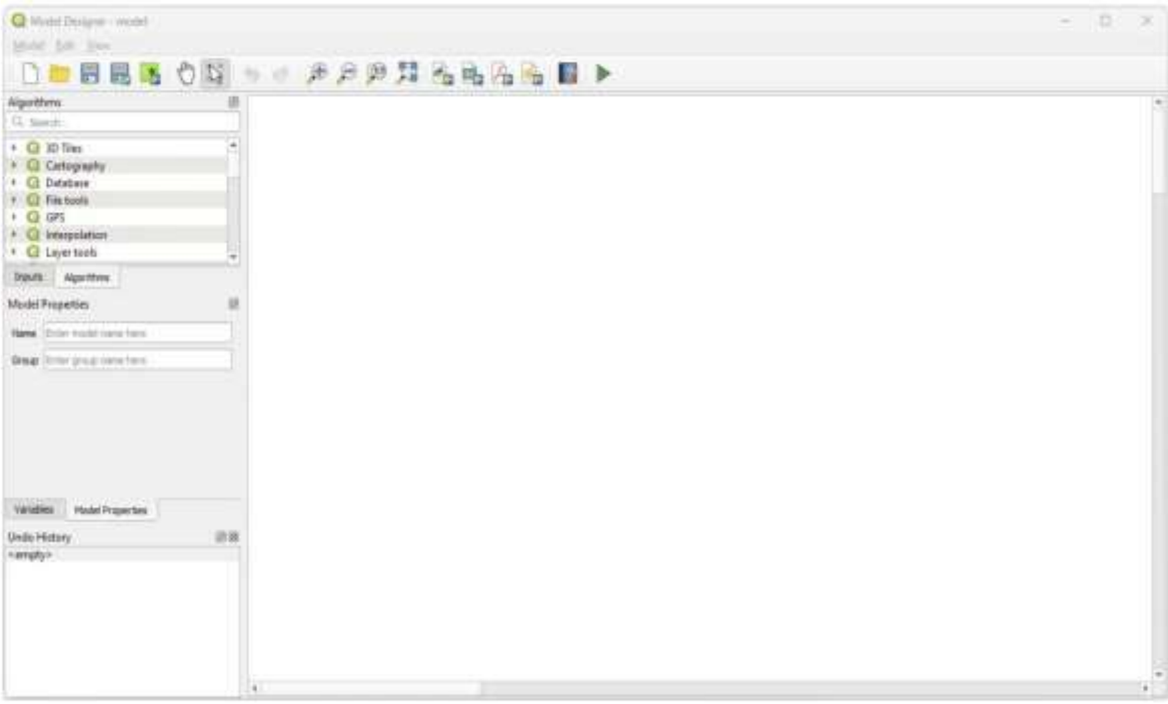

Figure 1: QGIS Model Designer Interface

METHODS

3.1 Concept of MDOW hillshade

MDOW hillshading is produced by:

1. Computing several hillshade rasters from the same DEM, each with a different azimuth but similar altitude.
2. Combining these individual hillshades into a composite raster using a weighted arithmetic expression.

Illumination azimuths are chosen to provide complementary perspectives, typically spanning the northwest, west, southwest, and north directions. In this scenario, azimuths of 360°, 315°, 270°, and 225° were used to emphasise oblique lighting while avoiding the strong directional artefacts of a single light source.

Weights can be uniform (simple average) or adjusted to emphasize certain directions; the decision depends on cartographic preference and the landscape being depicted.

3.2 Building the model in QGIS

All steps are implemented inside the **QGIS Graphical Modeler** (Processing → Model Designer). The main components are an input parameter, four hillshade processes, and a final raster-calculator step.

3.2.1 Define the model input

1. Open **Model Designer** and create a new model.
2. Under Inputs, add a **Raster Layer** parameter.

3. Name it DEM and provide a descriptive label such as “Input DEM for MDOW hillshade”.
4. This parameter becomes the single user-supplied input when the model is executed.

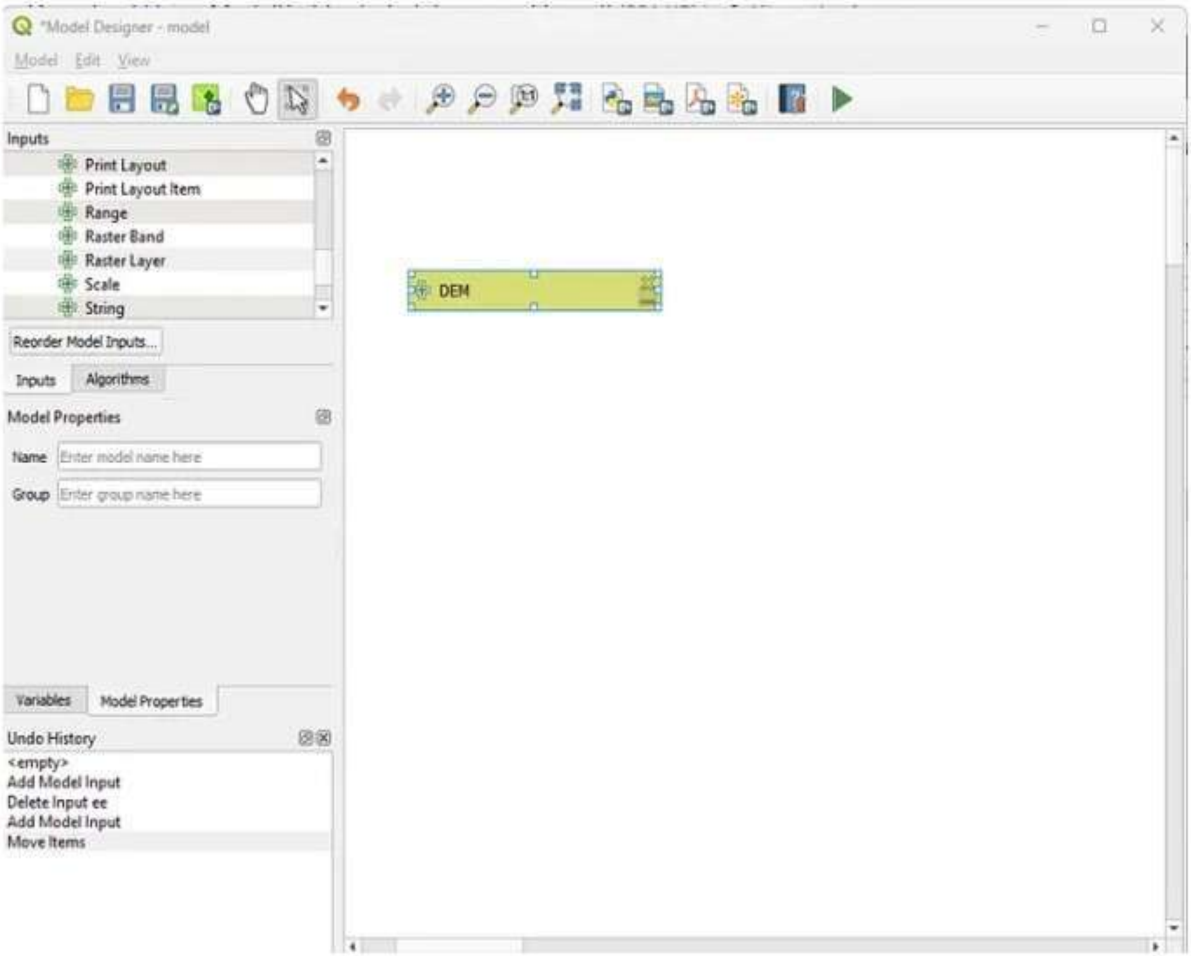

Figure 2 shows the Model Designer with an input parameter

3.2.2 Add multiple hillshade algorithms

For each illumination direction, add a hillshade algorithm as shown in Figure 3:

1. From Algorithms, drag **Hillshade** (under Raster terrain analysis) into the model canvas.
2. Set the **Elevation layer** to the DEM input.
3. Specify an **azimuth** and **altitude** value consistent with your standard.
4. Leave the z-factor and scale at defaults unless your DEM is in degrees or has non-metric elevation units.
5. Name the output.

Repeat this step three more times, creating hillshades with azimuths **315°, 270° and 225°** and giving each a distinct output name (e.g., hls_315, hls_270, hls_225). The resulting model canvas contains the DEM input branching into four hillshade nodes, mirroring the graphical layout shown in the original tutorial.

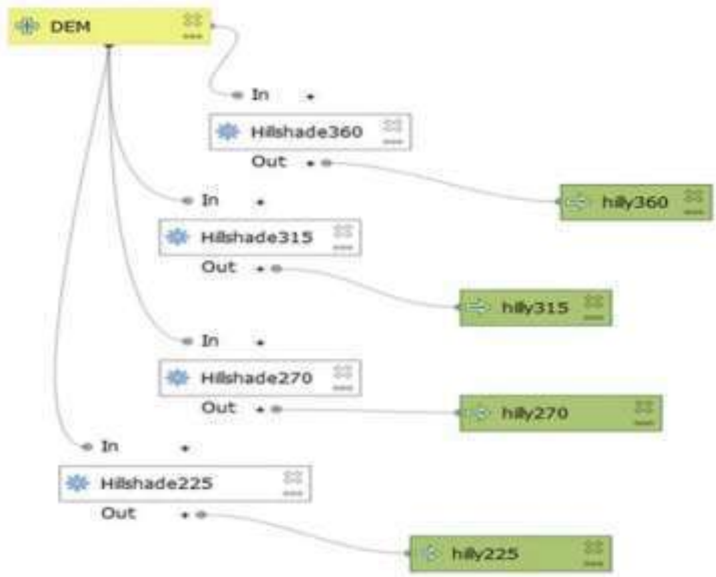

Figure 3: Snapshot of model designer after creating all four hillshades

3.2.3 Combine hillshades with the Raster Calculator

1. From Algorithms, add **Raster calculator** (GDAL) to the model.
2. In the Raster calculator dialogue, add each hillshade output as a raster layer.
3. Define an expression that combines the four hillshades into a single MDOW raster. A simple example with equal weighting is:

MDOW = (hls_360 + hls_315 + hls_270 + hls_225) / 4

where each term corresponds to the associated hillshade band. Practitioners can assign different weights, like giving slightly higher weight to 315° and 270° azimuths, to highlight a preferred lighting effect. The main idea is that all weighting is incorporated into the model, ensuring transparent and repeatable results.

4. Set the output layer name, choose an appropriate data type (usually Float32 or Int16), and specify the output.

5. Connect the four hillshade outputs to the raster calculator node in the model canvas. The final model includes a single DEM input, four parallel hillshade branches, and a raster calculator node, as shown in Figure 4, which produces the MDOW hillshade in Figure 5.

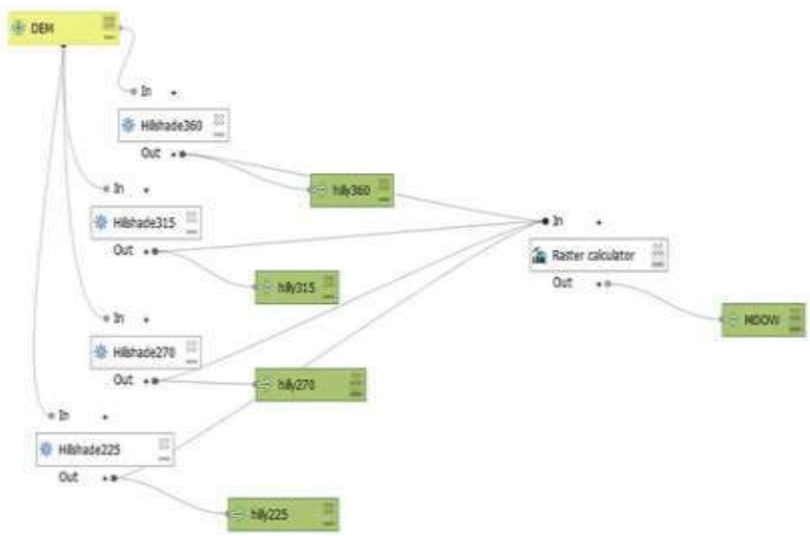

Figure 4 Graphical modeler for MDOW.

Figure 5 MDOW.

3.2.4 Saving and running the model

1. Save the model with a descriptive name such as MDOW Hillshade (4-direction) and a suitable group (e.g., Terrain Tools).
2. The model now appears in the QGIS Processing Toolbox.
3. To run it, double-click the model, select a DEM raster as the input, and specify an output file location.
4. The model executes all steps in sequence and produces a single MDOW hillshade raster, ready for symbolisation and use in map layouts.

4. Application and results

When used with real-world DEMs, the MDOW hillshade shows terrain with a more uniform distribution of light and shadow compared to a single-direction hillshade. Narrow valleys and ridges are visible regardless of their orientation, and the "striped" appearance often seen with one azimuth is greatly reduced. The final image resembles the example output in the original article, where MDOW shading reveals subtle landforms across the entire DEM.

The model can be used:

- As a background layer for thematic maps (e.g., land-use, geology, hydrology).
- As an aid to geomorphological interpretation and field planning.
- As a base for further terrain derivatives (e.g., overlaid with slope or curvature).

DISCUSSION

5.1 Advantages for practitioners

Using the QGIS Graphical Modeler for MDOW hillshade offers several benefits:

- **Reproducibility:** All parameters (azimuths, altitude, weights, data type) are stored in the model, eliminating manual re-entry and reducing the chance of error.

- **Efficiency:** Practitioners can run the model on multiple DEMs with minimal interaction, making it suitable for regional-scale studies and batch processing.

- **Transparency:** The visual model layout makes it easy for colleagues to review, adapt, and extend the workflow.

- **Portability:** The model file can be shared with other users or included alongside project documentation, encouraging standardised hillshading practices within teams.

5.2 Limitations and considerations

- **DEM quality:** MDOW hillshade cannot compensate for artefacts in the underlying DEM (e.g., voids, striping, uncorrected sinks). Pre-processing such as filtering, hydrological conditioning, or resampling may be necessary.

- **Computation time:** Generating multiple hillshades is more costly than one, particularly for very high-resolution DEMs. However, automation via the model mitigates user time costs.

- **Parameter choices:** Different landscapes may benefit from different azimuth sets or weighting schemes. Practitioners should experiment with small subsets before standardising settings for an entire project.

CONCLUSIONS

This paper demonstrates how the QGIS Graphical Modeler can be used to encapsulate the Multi-Directional Oblique Weighted hillshade workflow into a single, reusable tool. By generating four hillshades with different azimuths and combining them via the Raster Calculator, practitioners obtain a more balanced and informative terrain representation while maintaining full control over parameter selection.

The approach is straightforward, relies solely on core QGIS functionality, and is easily extended. Future enhancements could include:

- Adding additional illumination directions or alternative weighting schemes.
- Including optional smoothing or contrast-stretch steps.
- Packaging the model with example datasets and style files for distribution through OSGeo-related repositories or QGIS plugin collections.

For GIS professionals who frequently work with elevation data, adopting a model-based MDOW hillshade workflow can significantly improve both cartographic quality and processing efficiency.

REFERENCE

1. ESRI, 2015. Take Your Terrain Mapping to New Heights. Arc News Special Supplement – Terrain Tools, ESRI, Redlands, CA.
2. Horn, B.K.P., 1981. Hill shading and the reflectance map. Proceedings of the IEEE 69(1), 14–47.
3. Jenness, J., 2015. DEM Surface Tools for ArcGIS (including Multi-Directional Oblique-Weighted Hillshade). Jenness Enterprises, Flagstaff, AZ. Available at: https://www.jennessent.com (accessed 15/11/2025).
4. QGIS Development Team, 2024. QGIS User Guide: Raster terrain analysis – Hillshade and Relief tools. QGIS Association. Available at: https://docs.qgis.org (accessed 15/11/2025).
5. QGIS Tutorials and Tips, 2023. Working with terrain data (QGIS 3): Hillshade and contours. Available at: https://www.qgistutorials.com (accessed 15/11/2025).
6. Šolín, M., et al., 2023. Not another hillshade: alternatives which improve visualizations of bathymetric data. Frontiers in Marine Science 10, 1266364.
7. Yoeli, P., 1965. Analytische Schattierung. Kartographische Nachrichten 15, 142–148.
8. Zevenbergen, L.W., Thorne, C.R., 1987. Quantitative analysis of land surface topography. Earth Surface Processes and Landforms 12(1), 47–56.

HOW TO CITE: Moses Tangwam*, Caleb Mensah, Automating Multi-Directional Oblique Weighted Hillshade in QGIS with the Graphical Modeler, Int. J. Sci. R. Tech., 2026, 3 (1), 281-286. https://doi.org/10.5281/zenodo.18326803