Open Access Earth System Science Data Discussions

Interactive comment on "An Explicit GIS-Based River Basin Framework for Aquatic Ecosystem Conservation in the Amazon" *by* Eduardo Venticinque et al.

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Response to reviewer's 1 comments

We thank the reviewer for his excellent detailed review and respond (IN CAPITALS) to each comment he raised below, Indicating the line numbers and text that were modified in each case. Revised manuscript with new line numbers is attached.

General comments

- A new chapter describing the main characteristics of Amazon basin should be added. OK, A NEW CHAPTER DESCRIBING THE AMAZON BASIN SYSTEM WAS ADDED: L43-79: SEE SECTION 4.1 AMAZON BASIN SYSTEM

- The coding of the generated sub-basins needs to be described in more detail. THE FOLLOWING TEXT WAS ADDED TO CLARIFY: L 212-215: BASIN CODE GENERATION, BASIN CODES FOR BL1 AND BL4 BASINS WERE DERIVED FROM THE NAMES OF THE PRINCIPAL RIVERS IN EACH POLYGON. CODES FOR BL5 – BL7 BASINS WERE CREATED COMBINING THE ASSOCIATED BL2 BASIN NAME WITH THE ID NUMBERS GENERATED AUTOMATICALLY WHEN EACH BASINS WAS DELIMITED.

- The generated river network and sub-basins show a large number of artefacts at the higher resolutions (see attached Figs. 1 to 3). This should be discussed in some detail. THE FOLLOWING TEXT WAS ADDED TO CLARIFY: L198-207: THE SHAPEFILE CONTAINING 1-11TH ORDER STREAMS WAS FILTERED TO REMOVE ANOMALOUS 1ST TO 3ND ORDER STREAMS WHICH WERE GENERATED ON OPEN WATER SURFACES AND WETLANDS DUE TO THE INACCURACY OF THE DEM AND THE FLOW DIRECTION GRID THAT WAS GENERATED FROM IT. THESE ANOMALIES CONSISTED OF SPURIOUS LOW ORDER STREAM SEGMENTS, GENERATED PREDOMINANTLY IN LOW RELIEF WETLAND ENVIRONMENTS WHERE VARIATION IN ELEVATION WAS EITHER EXTREMELY LOW (OPEN WATER ENVIRONMENTS) OR DUE PRIMARILY TO VARIATIONS IN VEGETATION HEIGHT. THE FILTER ELIMINATED 1-3 ORDER STREAMS PRESENT IN THE WETLAND MASK AND STREAM SEGMENTS ADJACENT TO AND INTERSECTING THE MASK THAT WERE DELIMITED BY BL7 BASINS. WHILE MOST OF THE ANOMALOUS SEGMENTS WERE REMOVED BY THE FILTER, SOME ARE STILL APPARENT AT HIGHER RESOLUTIONS.

- The DEM used for the analysis should also be made available, if possible. THE PROBLEM IS THE SIZE OF THE DEM FILE (9.1 GB) WHICH IS LARGER THAN THE LIMIT FOR FREE STORAGE AT THE KNB SITE (5 GB).

- Many references are missing. ALL MISSING REFERENCES HAVE BEEN INCLUDED

Specific comments:

L48: Check citation format. CITATION FORMATS HAVE ALL BEEN CHECKED AND CORRECTED WHERE NECESSARY

L52: "The Amazon basin covers. . ." CORRECT, THIS TEXT WAS MODIFIED IN THE NEW CHAPTER DESCRIBED BELOW

L52-69: This paragraph does not well fit here. Instead it should be part of a separate chapter describing the Amazon basin. L43-79: OK, THIS TEXT WAS MODIFIED AND INCLUDED IN THE NEW CHAPTER

L54-55: Check citation format. CITATION FORMATS HAVE ALL BEEN CHECKED AND CORRECTED WHERE NECESSARY

L75-76: Define difference between "basin" and "watershed" TO REDUCE CONFUSION WE NOW USE ONLY BASINS TO DESCRIBE DELIMITED DRAINAGE AREAS AND HAVE ELIMINATED THE TERM WATERSHED FROM THE TEXT. L85-87: ". . .AND THE BASINS DELINEATED IN THIS SYSTEM ARE REFERRED TO AS PFAFSTETTER BASINS (OR OTTO-BASINS, IN BRAZIL). EACH DELINEATED BASIN IS ASSIGNED AN IDENTIFICATION NUMBER THAT ESTABLISHES A HIERARCHICAL AND SEQUENTIAL"

L79: Reference is missing. ALL MISSING REFERENCES HAVE BEEN INCLUDED

L82: "local interpretation"? Explain in more detail. LOCAL INTERPRETATION, IN THIS CONTEXT REFERS TO USE OF A SPECIFIC BASIN DELINEATION ADAPTED FOR LOCAL OBJECTIVES. THE TEXT HAS BEEN CHANGED AND AN EXAMPLE HAS BEEN GIVEN TO CLARIFY THIS. L93-95: "BUT COMPLEMENTARY CLASSIFICATIONS, ADAPTED FOR SPECIFIC LOCAL OBJECTIVES, SUCH AS THE DEVELOPMENT OF THE STRATEGIC PLAN OF HYDROLOGICAL RESOURCES OF THE RIGHT MARGIN OF THE RIO AMAZONAS HAVE ALSO BEEN ADOPTED (AGÊNCIA-NACIONAL-DE-ÁGUAS-(BRASIL)-ANA, 2012)."

C3

L80: Verdin and Verdin (1999) applied this method only to North America. L90-91: WE AGREE AND THE TEXT IS CHANGED ACCORDINGLY.

L100: "spatially dynamic conservation. . ." sounds strange ROBUST WAS SUBSTITUTED FOR DYNAMIC IN THIS PHRASE TO IMPROVE COHERENCY. L110: "FOR A SPATIALLY ROBUST CONSERVATION AND MANAGEMENT FRAMEWORK."

L103: "help providing" L116: TEXT WAS CHANGED TO: "HELP BY PROVIDING"

L113: "Amazon basin" L122: TEXT WAS CHANGED AS INDICATED

L129: "early rising water period"? Explain in more detail. THE FOLLOWING TEXT WAS CHANGED TO CLARIFY: L142-143: "THE EARLY RISING WATER PERIOD IN THE CENTRAL AMAZON REGION, WHEN THE AMAZON MAINSTEM BEGINS ITS 10-12 METER ANNUAL FLOOD CYCLE."

L158-166: Put this data into a table. OK NEW TABLE WITH THIS DATA WAS ADDED: L459:

L177: Delete "units". L181: OK, TEXT WAS DELETED

L181: Reference is missing. ALL MISSING REFERENCES HAVE BEEN INCLUDED

L181-186: This is unclear. Please describe in greater detail. THE FOLLOWING TEXT WAS CHANGED TO CLARIFY: L183-190: "A STREAM GRID WITH AN UPSTREAM STREAM THRESHOLD OF 100 PIXELS (APPROXIMATELY 81 HA) WAS USED TOGETHER WITH THE FLOW DIRECTION GRID AND THE SPATIAL ANALYST "STREAM ORDER" TOOL TO CREATE AN ORDERED (STRAHLER 1957) HIGH RESOLUTION STREAM GRID. THIS ORDERED STREAM GRID WAS THEN VECTORIZED WITH THE SPATIAL ANALYST "STREAM TO FEATURE" TOOL TO PRODUCE A SINGLE HIGH RESOLUTION STREAM NETWORK SHAPE FILE FOR THE ENTIRE AMAZON BASIN CONTAINING A STREAM ORDER ATTRIBUTE. THE CALCULATED STREAM ORDER VARIED FROM 1 TO 11 IN THIS PRODUCT WHICH IS PROBABLY UNDERESTIMATED BY 1 ORDER, SINCE THE DRAINAGE AR-

C4

EAS OF FIRST ORDER STREAMS, DEFINED ACCORDING TO STRAHLER (1957) AS PERMANENT STREAMS WITH NO PERMANENT UPSTREAM TRIBUTARIES, TEND TO VARY FROM 10-50 HA IN THE CENTRAL AMAZON BASIN."

L185: "according to" instead of "by" L189: OK, TEXT CHANGED

L194-196: Was this done manually? How did you identify anomalies? THE RESPONSE HERE IS THE SAME AS THE RESPONSE TO: "- THE GENERATED RIVER NETWORK AND SUB-BASINS SHOW A LARGE NUMBER OF ARTEFACTS AT THE HIGHER RESOLUTIONS (SEE ATTACHED FIGS. 1 TO 3). THIS SHOULD BE DISCUSSED IN SOME DETAIL." L198-205: THE SHAPEFILE CONTAINING 1-11TH ORDER STREAMS WAS FILTERED TO REMOVE ANOMALOUS 1ST TO 3ND ORDER STREAMS WHICH WERE GENERATED ON OPEN WATER SURFACES AND WETLANDS DUE TO THE INACCURACY OF THE DEM AND THE FLOW DIRECTION GRID THAT WAS GENERATED FROM IT. THESE ANOMALIES CONSISTED OF SPURIOUS LOW ORDER STREAM SEGMENTS, GENERATED PREDOMINANTLY IN LOW RELIEF WETLAND ENVIRONMENTS WHERE VARIATION IN ELEVATION WAS EITHER EXTREMELY LOW (OPEN WATER ENVIRONMENTS) OR DUE PRIMARILY TO VARIATIONS IN VEGETATION HEIGHT. THE FILTER ELIMINATED 1-3 ORDER STREAMS PRESENT IN THE WETLAND MASK AND STREAM SEGMENTS ADJACENT TO AND INTERSECTING THE MASK THAT WERE DELIMITED BY BL7 BASINS. WHILE MOST OF THE ANOMALOUS SEGMENTS WERE REMOVED BY THE FILTER, SOME ARE STILL APPARENT AT HIGHER RESOLUTIONS.

L197: Is this correct? In the other cases the Hydro Tools of ArcGis were used. NO, IT IS INCORRECT. ALL DATA IN THE FINAL VERSION WERE CALCULATED USING ARCGIS 10.1. THE TEXT WAS CHANGED ACCORDINGLY: L206-207: THE LENGTH (KM) OF EACH SEGMENT IN THE FULL RESOLUTION NETWORK WAS ALSO DETERMINED WITH THE ARCGIS 10.1 IN SOUTH AMERICA ALBERS EQUAL AREA CONIC PROJECTION.

L224: What names? Did you still use the Pfafstetter Coding System? ALL MAJOR AND MINOR TRIBUTARY BASINS WERE ATTRIBUTED THE NAME OF THE PRINCIPAL TRIBUTARIES IN EACH POLYGON. L212-215: BASIN CODE GENERATION, BASIN CODES FOR BL1 AND BL4 BASINS WERE DERIVED FROM THE NAMES OF THE PRINCIPAL RIVERS IN EACH POLYGON. CODES FOR BL5 – BL7 BASINS WERE CREATED COMBINING THE ASSOCIATED BL2 BASIN NAME WITH THE ID NUMBERS GENERATED AUTOMATICALLY WHEN EACH BASINS WAS DELIMITED.

L222: How did you derive the point shapefile for basin outlets? THE TEXT BELOW WAS MODIFIED TO EXPLAIN THIS PROCEDURE: L234-239: BASIN GRIDS FOR MAJOR AMAZON TRIBUTARIES (BL2), MAJOR TRIBUTARIES (BL3) AND MINOR TRIBUTARIES (BL4) WERE CREATED FROM THE FLOW DIRECTION GRID AND A POINT SHAPEFILE FOR BASIN OUTLETS USING THE WATERSHED DELINEATION TOOL OF ARCHYDRO 2.0 FOR ARCGIS. BASIN OUTLETS WERE CREATED WITH THE POINT GENERATION FEATURE OF THIS TOOL. BASIN GRIDS WERE CONVERTED TO POLYGON SHAPEFILES USING THE HYDRO TOOLS "POLYGON PROCESSING" TOOL. ALL MAJOR AND MINOR TRIBUTARY BASINS WERE ATTRIBUTED AREAS AND THE NAME OF THE PRINCIPAL TRIBUTARIES IN EACH POLYGON.

L233-234: This is not correct. Actually, the floodplain is defined as the area adjacent to a river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge. As such its areal extend is more or less constant in time. In addition it is unclear to which influence of the floodplain you are referring to (e.g. runoff generation?). WE AGREE WITH THIS POINT. WE WERE REFERRING TO INUNDATE AREAS, NOT FLOODPLAIN AREAS. WE HAVE ADJUSTED THE TEXT ACCORDINGLY: L247-251: LARGE RIVER FLOODPLAINS PLAY AN IMPORTANT ROLE IN THE AMAZON, SUSTAINING AQUATIC PRIMARY PRODUCTION AND FISH YIELDS IN THE REGION. AT HIGH WATER, WHEN THE INUNDATED AREA OF FLOODPLAINS IS GREATEST,

MANY SMALL TRIBUTARIES ARE COMPLETELY FLOODED ALTERING REGIONAL DRAINAGE PATTERNS. MANY OF THESE TRIBUTARIES WHICH ARE INDEPENDENT OF THE MAIN CHANNEL AT LOW WATER ARE "CAPTURED" BY FLOODING AND INCORPORATED IN THE MAINSTEM DRAINAGE AT HIGH WATER.

L235: The term "high water drainage patterns" is unclear. Explain in more detail. THESE HIGH WATER DRAINAGE PATTERNS WERE DEFINED IN OUR RESPONSE TO THE PREVIOUS COMMENT AND REFLECTED IN THE NEW TEXT: L248-151: "AT HIGH WATER, WHEN THE INUNDATED AREA OF FLOODPLAINS IS GREATEST, MANY SMALL TRIBUTARIES ARE COMPLETELY FLOODED ALTERING REGIONAL DRAINAGE PATTERNS. MANY OF THESE TRIBUTARIES WHICH ARE INDEPENDENT OF THE MAIN CHANNEL AT LOW WATER ARE "CAPTURED" BY FLOODING AND INCORPORATED IN THE MAINSTEM DRAINAGE AT HIGH WATER. ".

L238-240: Explain in greater detail, how you derived the wetland mask for the radar imagery. The text was modified to explain this better: L255-260: THE WETLAND MASK USED TO IDENTIFY FLOODPLAIN ENVIRONMENTS WAS GENERATED BY HESS ET AL. (2003) FROM THE ANALYSIS OF JERS-1 L BAND RADAR IMAGERY COVERING MOST OF THE LOWLAND AMAZON BASIN ACQUIRED DURING BOTH LOW AND HIGH WATER PERIODS. DETAILED METHODS ARE PROVIDED IN THE ORIGINAL REFERENCE. WETLANDS WERE DEFINED AS AREAS THAT WERE INUNDATED DURING EITHER OF BOTH PERIODS TOGETHER WITH AREAS ADJACENT TO FLOODED AREAS WHICH DISPLAYED LANDFORMS CONSISTENT WITH FLOODPLAIN GEOMORPHOLOGY.

L258: Reference is missing. OK, REFERENCE WAS ADDED

L262: The method needs to be explained in greater detail incl. references to information sources and optical data. How does this classification compare to Sioli 1968? More text and a reference was added: L280-282: WE DEFINED WATER

TYPE (WHITE, BLACK OR CLEAR) IN 6TH – 11TH ORDER RIVERS BASED ON REGIONAL KNOWLEDGE AND VISUAL ANALYSIS OF OPTICAL IMAGERY OF VARIOUS RESOLUTIONS AVAILABLE THROUGH GOOGLE EARTH (GOOGLE INC).

L296-307: The conclusions chapter should be rewritten in a way that better presents the main outcomes of this work. Also some aspects are missing, e.g. river distance. L316-332: THE MULTI-LEVEL BASIN HIERARCHY AND CLASSIFIED RIVER NETWORK DEVELOPED HERE PROVIDES A NEW SPATIAL FRAMEWORK FOR ANALYZING AQUATIC AND TERRESTRIAL DATA AT A VARIETY OF SUB-BASIN LEVELS, INCLUDING THE AMAZON BASIN AND AMAZON REGION AS A WHOLE. ITS ARCHITECTURE IS APPROPRIATE FOR USE IN MONITORING AND MANAGEMENT OF AQUATIC ECOSYSTEMS, ESPECIALLY WITHIN AN INTEGRATED RIVER BASIN MANAGEMENT FRAMEWORK AT DISTINCT SPATIAL SCALES. THE PRINCIPAL DATA PRODUCTS PROVIDED IN THE GIS INCLUDE: 1. A MULTI-LEVEL BASIN HIERARCHY SPECIFICALLY DESIGNED FOR THE CONSERVATION AND MANAGEMENT OF RIVER BASINS AND FLOODPLAIN ENVIRONMENTS AT A VARIETY OF BASIN AND SUB-BASIN SCALES. 2. A HIGH RESOLUTION (1-2ND ORDER), SPATIALLY UNIFORM, ORDERED DRAINAGE NETWORK FOR THE AMAZON BASIN AND ITS ADJACENT COASTAL BASINS (COASTAL NORTH, COASTAL SOUTH AND TOCANTINS). 3. A FIRST APPROXIMATION OF RIVER TYPES BASED ON WATER COLOR AS A PROXY FOR DISTINCT CHEMICAL CHARACTERISTICS, INCLUDED AS AN ATTRIBUTE FOR 6-11TH ORDER TRIBUTARIES. 4. ESTIMATES OF THE DISTANCE OF INDIVIDUAL STREAM SEGMENTS FROM THE MOUTH OF THE AMAZON RIVER, INCLUDED AS AN ATTRIBUTE FOR 4-11TH ORDER STREAMS IN THE AMAZON BASIN. 5. A POINT SHAPE FILE INDICATING CONFLUENCES (NODES) OF DIFFERENT RIVER TYPES THAT ARE CRITICAL SPAWNING ZONES FOR MIGRATING FISH SPECIES. THIS REGIONAL HYDROLOGICAL DATABASE PROVIDES A COHERENT FRAMEWORK FOR THE INTEGRATION AND ANALYSIS A WIDE ARRAY OF SPATIAL DATA, CRITICAL FOR MANAGEMENT AND CONSERVATION OF THIS VALUABLE FLUVIAL ECOSYSTEM.

References need to be sorted alphabetically. OK

Figure 1: - "of the first" - "BL =" - increase fond size - add BL1, BL2 etc. to the sub panels WE AGREE WITH THIS POINT AND HAVE ADJUSTED THE TEXT OF LEGEND AND FONT SIZE ACCORDINGLY L486-287: FIG. 1. CARTOGRAPHIC REPRESENTATION OF AMAZON BASIN CLASSIFICATION DATA OF FIRST 4 LEVELS. A) BL1, B) BL2, C) BL3 AND BL4. BL = BASIN LEVEL

Figure 5: - A lot of confluence nodes seems to be missing WE AGREE WITH THIS POINT AND HAVE ADJUSTED THE TEXT OF LEGEND ACCORDINGLY WITH THE MAP. THE GEODATABASE HAVE OTHER SHAPEFILE OF GENERAL NODES (NODESGENERAL.SHP) NOT REPRESENTED IN THIS FIGURES OF THIS DATA-PAPER: L514-516: FIG. 5. CARTOGRAPHIC REPRESENTATION OF IMPORTANT CONFLUENCE AREAS FOR SPAWNING, DERIVED FROM THE INTERSECTION OF SPAWNING NODES AND SUB-BASINS OR MAIN STEM DRAINAGES IMPORTANT FOR COMMERCIAL FISHING.

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Please also note the supplement to this comment:
http://www.earth-syst-sci-data-discuss.net/essd-2016-17/essd-2016-17-AC1-supplement.pdf

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