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Hydrodynamics and contaminant transport on a
degraded bed at a 90-degree channel confluence.
Environmental Fluid Mechanics, 18(2), 443-463"**

Sébastien Pouchoulin, Pedro Xavier Ramos, Emmanuel Mignot, Laurent
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1 Discussion of “Tang, H., Zhang, H., & Yuan, S. (2018). *Hydrodynamics and contaminant transport on*
2 *a degraded bed at a 90-degree channel confluence. Environmental Fluid Mechanics, 18(2), 443-463*”

3 Sebastien Pouchoulin¹, Pedro Xavier Ramos², Emmanuel Mignot¹, Laurent Schindfessel², Tom De
4 Mulder² and Nicolas Riviere¹

5 ¹ Univ-Lyon, INSA Lyon, LMFA, UMR5509, F-69621 Villeurbanne, France.

6 ² Hydraulics Lab., Department of Civil Engineering, Ghent University, Belgium.

8 **Abstract**

9 The authors measured and computed the hydrodynamics and passive scalar dispersion in 90-degree
10 open channel confluences over flat and degraded beds with a dominant upstream or tributary inflow.
11 The present discussion essentially deals with the direction of rotation of the secondary currents,
12 reported for the flat bed configuration with dominant tributary inflow. This rotation direction is indeed
13 surprisingly opposite to the ones reported in the literature, both from calculations and measurements,
14 even if present geometry slightly differs from literature geometries.

15

16 **Discussion**

17 The authors present an interesting work on hydrodynamics and passive scalar transport in asymmetric
18 open-channel confluences both over flat and degraded beds. The paper deals notably with degraded
19 bed configurations, which bring undoubtedly interesting new knowledge, since flat bed intersections
20 have been more frequently addressed. The comparison of these existing flow descriptions with the
21 authors' results motivates the present discussion. This is especially the case for the 90° angle
22 confluences in which the three branches have a rectangular cross-section of equal width (*i.e.* a
23 geometry which differs somewhat from the one considered by the authors, where the downstream
24 branch has a 33% larger width than the tributary and the upstream branches). Several flow structures
25 are reported by *e.g.* Best (1985), Shumate (1998) and Weber *et al.* (2001): the shear layer at the
26 interface, the stagnation zone, the recirculation zone and the secondary currents in the downstream
27 branch. In particular, as the momentum ratio between the tributary and upstream branches (which
28 simplifies into the square of discharge ratio for equal widths of the incoming branches) exceeds 1, a
29 helix-shaped secondary current occurs in the accelerated flow region besides the recirculation zone of
30 the downstream branch. Further downstream, this helix-shaped current occupies most of the section of

31 the downstream branch. As mentioned by the authors, this secondary current strongly affects the
32 passive scalar transport downstream from the confluence (see also *e.g.* Chen *et al.*, 2017).

33 For the aforementioned confluence case (*i.e.* a concordant flat bed case with equal width channels and
34 a tributary to upstream momentum ratio exceeding 1), the flow patterns were previously measured by
35 Weber *et al.* (2001) and Schindfessel *et al.* (2015) (with a chamfered rectangular cross-section) and
36 computed by Huang *et al.* (2002), Shakibainia *et al.* (2010), Yang *et al.* (2013), Riviere *et al.* (2015)
37 and Schindfessel *et al.* (2015). All these works indeed report a helix-shaped secondary current in the
38 accelerated flow region besides the recirculation zone (and beyond) of the downstream branch.
39 Nevertheless, the rotation direction of this helix-shaped current differs from the one computed by the
40 authors in their scenario S3/S7. All previous works report a secondary flow coming from the tributary
41 that passes above the upstream flow, then plunges along the opposite wall and returns towards the
42 tributary bank along the near-bed layer. For the sake of conciseness, this rotation direction will be
43 referred to as “classical” in the sequel. Oppositely, the authors’ S3/S7 flow pattern (plotted in figure 7,
44 3rd column and 3rd to 5th line) exhibits a helical motion in the opposite rotation direction, with the
45 tributary flow plunging below the upstream flow towards the opposite wall, then rising along this
46 opposite wall ($y/W_d \sim 1$), returning towards the tributary bank ($y/W_d \sim 1$) in the near-surface layer and
47 finally plunging to close the loop. As this computed direction of rotation is the opposite from the
48 classical one, it would be necessary to compare it to experimental data for verifications. Unfortunately,
49 measured transverse velocities characterizing the secondary flow are not shown for scenario S3/S7.
50 Therefore, discussers would be grateful if the authors can plot the secondary current measured for this
51 scenario and discuss the computed rotation direction.

52 Regarding passive scalar dispersion, Riviere *et al.* (2015) in their figures 5 and 7 (right column) show
53 that the secondary current rapidly transports by advection i) water coming from upstream towards the
54 tributary bank along the near-bed region and ii) water from the tributary to the opposite bank along the
55 near-surface region, *i.e.* along the classical rotation direction. The mixing efficiency is then enhanced
56 for this tributary dominated configuration compared to the flow patterns with an upstream velocity
57 exceeding that of the tributary. Oppositely, the scalar fields computed by the authors indicate that their
58 tributary flow (red in figure 8c and blue in figure 9c) plunges below the upstream flow and is

59 transported towards the opposite bank along the near bed region, while the water from the upstream
60 flow is transported towards the tributary bank along the near-surface region. Riviere *et al.* (2015) then
61 conclude that “these helical motions strongly enhance the mixing process”. This is a strong
62 contradiction with the author’s statement that “... the magnitudes of V and W components are very
63 small, and thus they have a limited effect on the flow structure and mixing at channel confluences”.

64 Reasons for the inverted computed helical motion by the authors cannot be attributed to the turbulence
65 model as the authors resolve the 3D-RANS equations using a Reynolds Stress Turbulence model,
66 similarly to Riviere *et al.* (2015), who retrieve the classical rotation direction of the secondary flow. It
67 can neither be attributed to the free-surface calculation technique as the authors apply the VOF
68 method, similar to Yang *et al.* (2013) in their run 5. The non-classical rotation direction may be related
69 to the vertical profiles of transverse velocity (along y axis) in the tributary near $y/W_d=0$ (Fig. 7, 1st line,
70 3rd row) showing a velocity maximum at a relatively low elevation above the bed, i.e. in the lower half
71 of the water column. This could be connected, perhaps, to the authors’ channel geometry where the
72 wider downstream branch forms a non-classical intersection compared to the literature. Again, a plot
73 of the experimental vertical profiles of transverse velocity at the upstream and downstream ends of the
74 tributary would be invaluable to conclude on this rotation direction being odd with the ones reported in
75 the literature.

76

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