Phase 6 estimate of TN delivery from atmospheric source

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Burns et al., 2020 (in review)

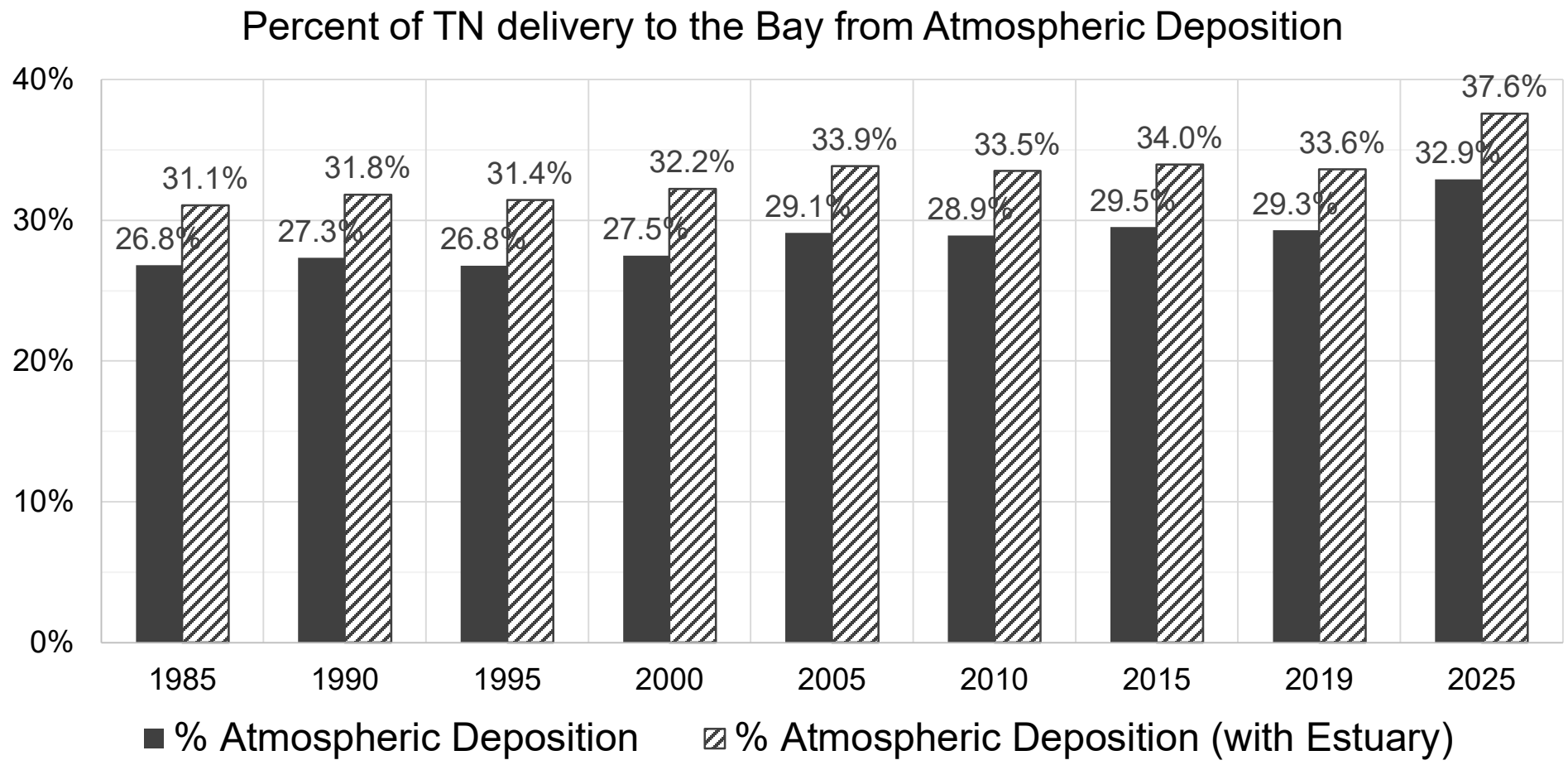
- Correll and Ford (1982) concluded that N in precipitation provided 40% of the external N load to the Rhode River Estuary.
- Fisher and Oppenheimer (1991) estimated that 25±5% of the annual load originated from atmospheric oxidized N (NO_x), another 14% originated as atmospheric reduced N (NH_x).
- Hinga et al. (1991) independently verified the findings of Fisher and Oppenheimer (1991), and confirmed that about one-third of N transported to the Bay originated from atmospheric deposition.
- Ronner, 1985 came to similar conclusion in other regions.
- Later assessments with further refinements concluded that about 25% of the N load to the Bay originated from atmospheric deposition (Castro et al., 2001; Castro and Driscoll, 2002; Boyer et al., 2002; Birch et al., 2011).
- Some studies added consideration of food and feed imports into the Chesapeake Bay watershed, that while not large (Castro and Driscoll, 2002; Boyer et al., 2002), lessened the relative role of atmospheric N deposition.
- SPARROW modeling by Alexander et al. (2001) estimated 28%, and Ator et al. (2011) 17%
- Linker et al. (2013) applied the CBP models to estimate that atmospheric N declined from about 32% to 27% of total N export to the Bay during 1985 to 2005.
- Ator et al. (2019): "*Nitrogen attributable to atmospheric deposition decreased by 20% between 1992 and 2012; such inputs, however, represented only a small fraction (<10%) of the total flux to the bay during either period.*"

Burns et al., 2020 (in review)

Citation	Year	Estimate (% total N load)	Uncertainty Range (% total N load)	Dry Dep Included?	Org N Included?	Comment
Fisher & Oppenheimer, 1991	1984	34	29 – 39[a]	Yes	No	Equal source retention
Fisher & Oppenheimer, 1991	1984	39	34 – 44[a]	Yes	No	Differential source retention
Hinga et al., 1991	1986	31	12 – 59[b]	Yes	No	
Jaworski et al., 1997	1990-93	61[c]	NA	Yes	Yes	Regression based on 17 sites
Alexander et al., 2001	early 1980s–93	28	22-34	No	No	Steady-state model, dep to Bay excluded
Castro et al., 2001	1979-96[d]	23	NA	Yes	No	Nitrate dep only
Castro & Driscoll, 2002	1997	27	NA	Yes	Yes	
Boyer et al., 2002	1991	25[c]	NA	Yes	Yes	Net atmos dep
Castro et al., 2003	1979-96[d]	30	NA	Yes	Yes	
Ator et al., 2011	2002	17	NA	No	No	Steady-state model, dep to Bay excluded
Birch et al., 2011	2008	24	NA	Yes	No	
Linker et al., 2013	1985–2005	1985=32 2005=27	NA	Yes	Yes[e]	Modeled dep, dep to Bay excluded
Ator et al., 2019	1992, 2012	<10	NA	No	No	Steady-state models, dep to Bay excluded

Estimated fraction of TN delivery to the tidal Bay from atmospheric source

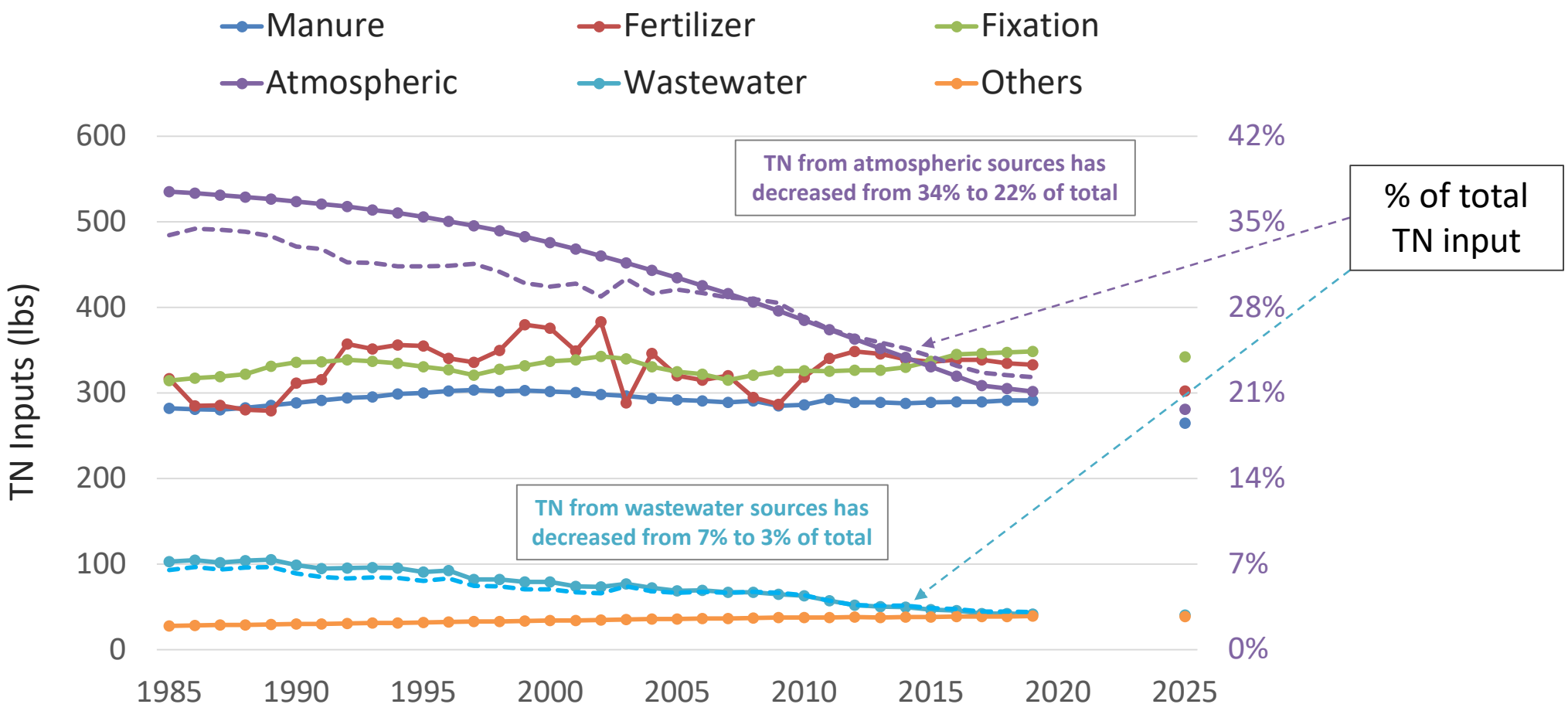
CAST v2019



27 to 33%
31 to 38%

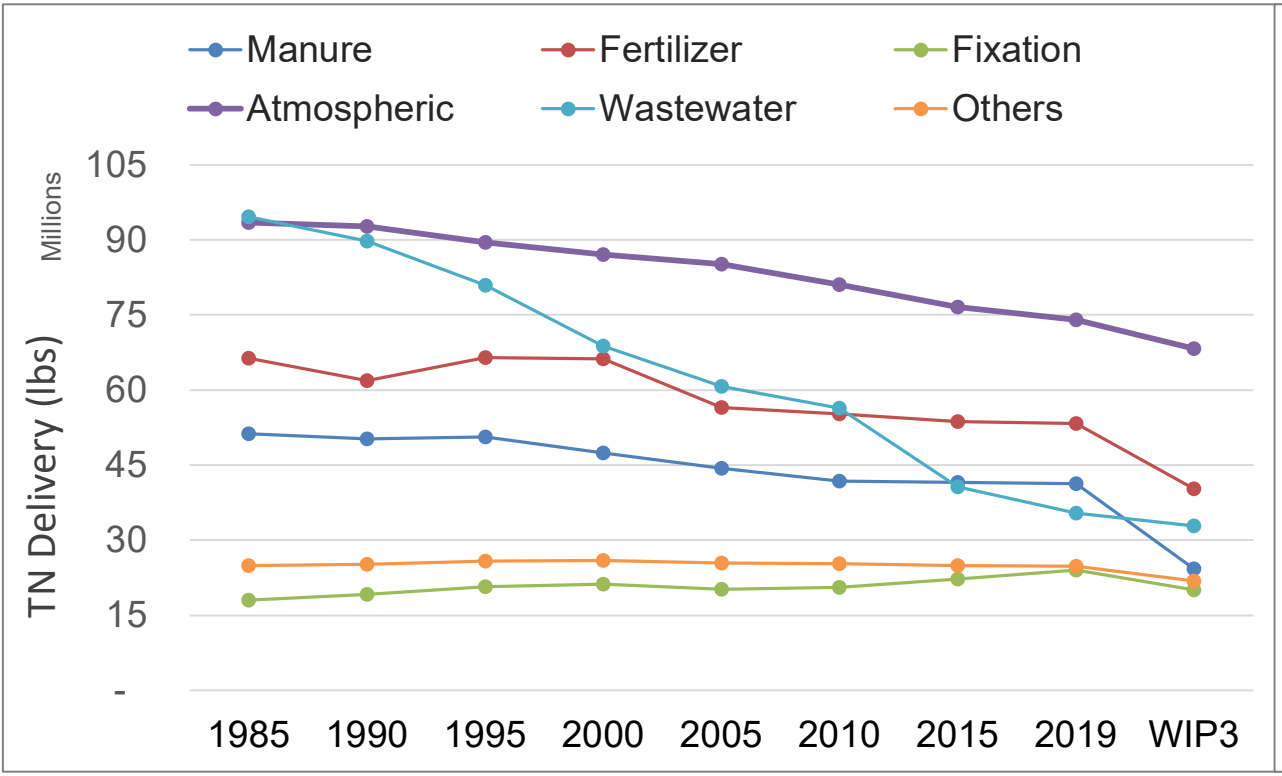
Phase 6 estimates of TN input to the Chesapeake Bay Watershed

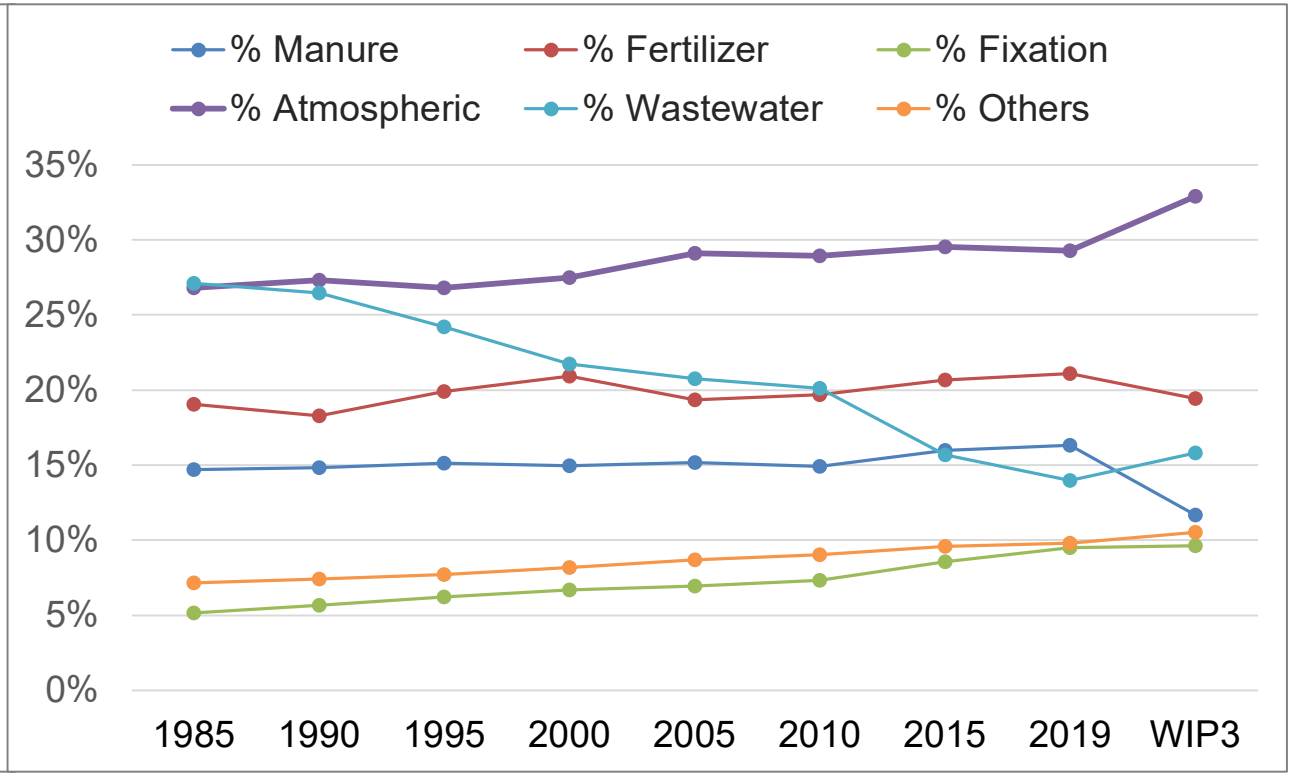
CAST v2019



Phase 6 estimates of TN delivery attributed to input sources

CAST v2019





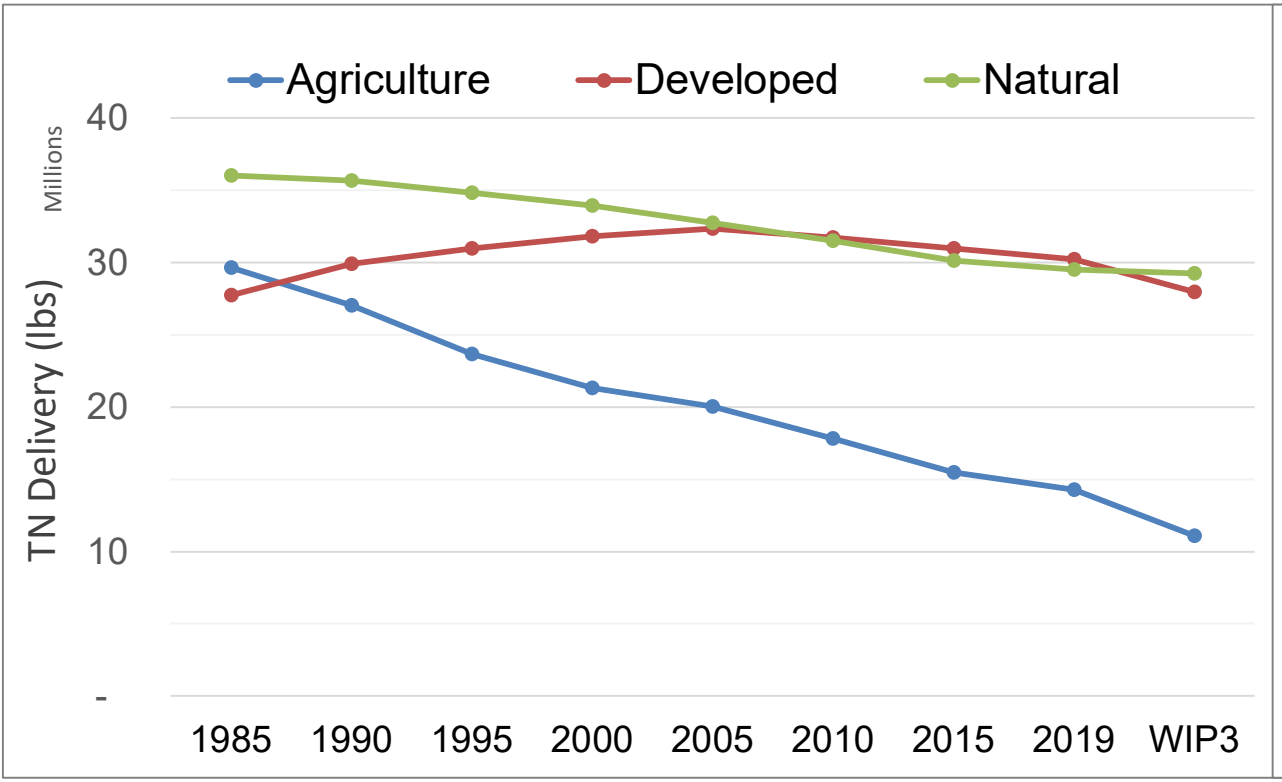
Estimated decreasing TN delivery is due a combination of changes in inputs, BMPs, and management actions.

Percent contribution of TN delivery (except for wastewater) show increasing trends, some more so than others.

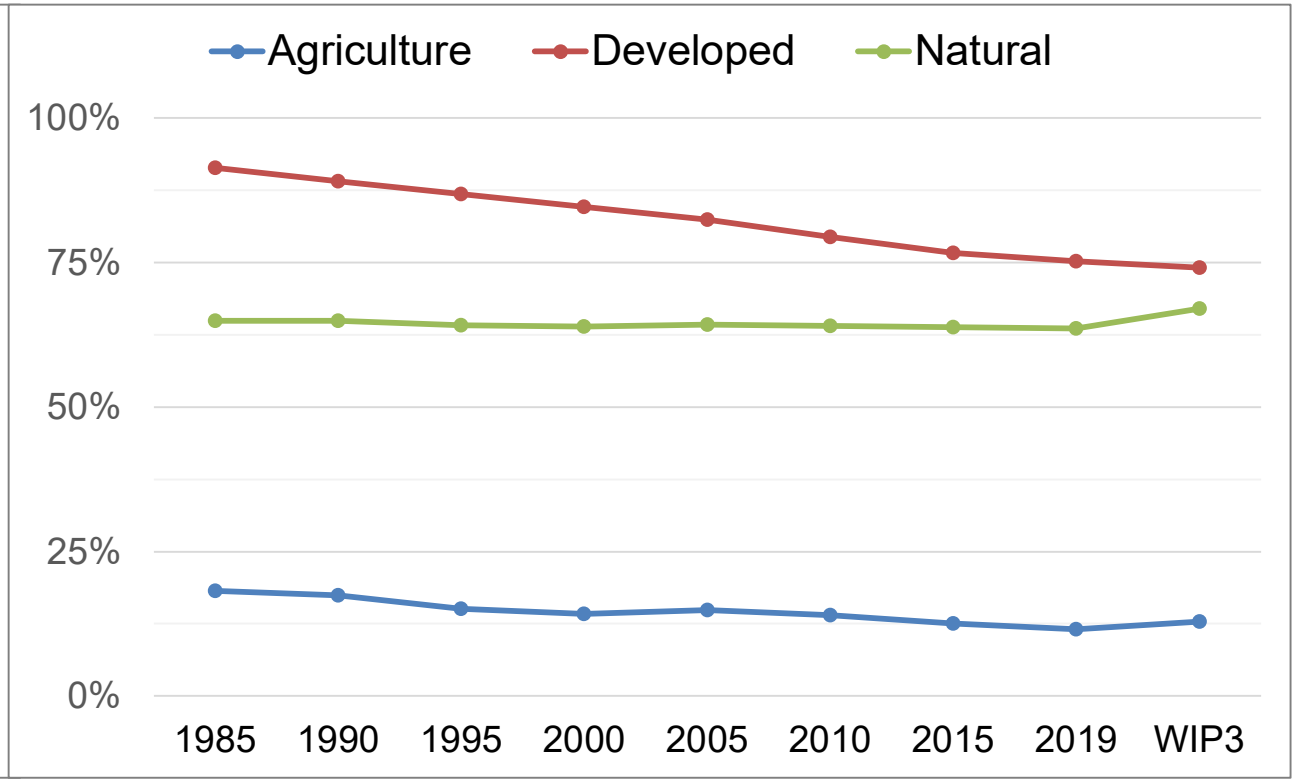
Phase 6 estimates of Atmospheric TN delivery attributed to Source Sectors

CAST v2019

Atmospheric TN Delivery from Source Sectors



Atmospheric TN Delivery from Source Sectors



Summary and Conclusions

- Phase 6 estimates show:
  - atmospheric depositions have been decreasing, from about 33% of the total TN inputs in 1985 to 22% in 2025.
  - atmospheric sources account for about 30% of TN delivery – 27% in 1985 Annual Progress to 33% under 2025 WIP3 conditions.
    - about 31 to 38% between 1985 to 2025 when atmospheric TN depositions to tidal open waters were also included.

- These percent estimates should not be interpretated as how much of the TN delivery can only be controlled from atmospheric sources.
  - *Marginal change in delivery for atmospheric N is much smaller as compared to other inputs.*